Using data to answer questions of public health importance for ACT Health, with an emphasis on routinely-collected linked data

A thesis submitted for the degree of Master of Philosophy in Applied Epidemiology (MAE) of the Australian National University

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November 2017

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Declaration

‘I hereby declare that this submission is my own work and to the best of my knowledge it contains no materials previously published or written by another person, or substantial proportions of material which have been accepted for the award of any other degree or diploma at the Australian National University or any other educational institution, except where due acknowledgment is made in the thesis. Any contribution made to the research by others is acknowledged in the thesis. I also declare that the intellectual content of this thesis is the product of my own work, except to the extent that assistance from others in the project’s design and conception or in style, presentation or linguistic expression is acknowledged’. ACT Health reserves all rights for the data used in this thesis. Any further distribution requires approval from the data custodian.

Signed
Yan Xu

Date 10 November 2017

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Acknowledgments

This research is supported by an Australian Government Research Training Program (RTP) Scholarship. I appreciate that this support was made available to me and is available to others who want to understand the world around us.

First and foremost, I would like to acknowledge and thank my academic supervisor, Rosemary Korda; and director of the Master of Applied Epidemiology (MAE) Program, Martyn Kirk. Thank you Rosemary for being an inspiring and caring supervisor. You have demonstrated a great passion for epidemiology and fostered a similar passion in me. Your thorough and rigorous approach to data analysis have been a highlight of my MAE journey. It was a privilege to learn from you and I am grateful for your wise guidance and reliable support. Martyn, you have always been able to provide practical advice and solutions when I faced challenges. Thank you in particular for supporting me when I returned from maternity leave to complete this program part-time and achieve my goals. You have both helped me to develop professionally and personally, so thank you.

I am grateful for working with the wonderful people in ACT Heath's Epidemiology Section. Thank you to my field supervisors, Hai Phung and Bridget O'Connor, for sharing your experience and expertise with me, and for being so flexible when I became a mother during the course of our work. Your support and assistance have made my MAE journey a rewarding and enjoyable experience. Special thanks to Oscar Yang, our 'nothing is impossible' biostatistician. I could not have completed my projects without your friendship and magic coding. Thank you Tracey Docherty and Wayne Anderson for all the administrative and IT support you have given me. Thank you too to Deb Welsh, Louise Freebairn and Leah Newman for sharing your corporate knowledge on my stakeholder consultation and ethics applications. And to everyone else who worked in the Epidemiology Section over 2015–2017, thank you for making me feel welcomed and part of the team.

I am fortunate to have very supportive and caring family members. To my husband, James, thank you for your patience, humour and encouragement through all the good and challenging parts of my studies. Mum, thank you for flying all the way from China to take care of us. Your command that “you go to work, I will look after the baby!” brought tears to my eyes and helped me so greatly. Oscar Jun, my precious baby, thank you for being you: happy, inquisitive, energetic and determined. You give me strength and belief in a happy work-life balance. Ruth and Alan, thank you for your generous and continuous support since the first day I arrived in Australia.

Lastly, thank you to my very special MAE cohort: Alex Marmor, Jana Lai, Samantha Siripol, Craig Thompson, Anthony Draper, Amy Burroughs, Darren Westphal, Alicia Arnott, Tambri Housen, Paul Dutton, Johanna Dups, and Tanyth de Gooyer, your friendship and support over this time has been wonderful. (Thanks Tanyth for editing the photo too!)

Abstract

My field placement was with the Epidemiology Section in the Population Health Protection and Prevention Division at ACT Health. Within this placement, I have completed four projects for this thesis: an analysis of Emergency Department (ED) data; a gastroenteritis outbreak investigation; an evaluation of a population health survey and, for my main project, a study of unplanned hospital readmissions. One of the motivations for undertaking these projects was to promote better use of the routinely-collected linked data to answer questions of public health importance for ACT Health.

My data analysis project was an analysis of frequent ED use in the Australian Capital Territory (ACT). This is the first study to quantify and characterise ED frequent users in the ACT. The results support existing evidence that frequent users tend to be older, female, and/or single, and commonly present with pain-related conditions. The data also showed that compared to non-frequent ED users, frequent users were more likely to be referred by police, corrective or community services; arrive by ambulance, not wait to be assessed, or leave at their own risk. In addition, we investigated visit intervals, rarely reported on in other studies. This study found around one third of frequent users returned within 7 days, with 41% of their visits having the same diagnosis as the last visit. Early identification and follow-up in the community for frequent users will assist in the development of targeted strategies to improve health service delivery to this vulnerable group.

Unexpected return to hospital has negative impacts on families and healthcare systems. We examined which conditions have the highest rates of readmission and contribute most to 30-day unplanned readmissions in the ACT, and which patient characteristics are associated with readmissions. The study identified a 30-day unplanned readmission rate of 6.2%, with admission rates highest for *alcohol-related liver disease (19.2%),* and *heart valve disorders (17.4%)*. Older age and comorbidities are strong predictors for 30-day unplanned readmissions. For some conditions the rates were relatively high, suggesting areas to target for reducing readmissions. Therefore, when developing preventative strategies

and post-discharge plans, particular consideration should be given to patients at older age or with underlying comorbidities.

As part of the ACT Health Survey Program (HSP), the ACT General Health Survey (GHS) is a computer-assisted telephone interviewing survey conducted every year among ACT residents. My evaluation of the GHS found that it is a useful tool to monitor trends of overweight, obesity, nutrition and physical activity for adults and children in the ACT. The data collected are used to provide evidence to understand and analyse overweight and obesity patterns in the ACT and create awareness of unhealthy lifestyles. However, improvements could be made in a few areas, including: developing a proper evaluation plan and a data quality statement, increasing the sample size and the proportion of young people in the sample population.

I also carried out an outbreak investigation of foodborne gastroenteritis that occurred among staff and public members at a large national institution in Canberra. I conducted two studies for this outbreak – a retrospective cohort study and a case control study. The epidemiological, environmental and laboratory evidence suggested the outbreak was caused by *C. perfringens* toxin Type A, with the likely vehicles of transmission being butter chicken and rice. The findings of this investigation suggest that a breakdown in temperature control and good food handling practices may have resulted in *C. perfringens* bacterium growing rapidly and producing a toxin which caused the illness. This project also indicated that the value of a second epidemiological study was questionable given the limited time and resources available.

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Summary of Core Competencies

MAE Competency	Chapter 2 Factors associated with frequent ED Use	Chapter 3 30-day unplanned readmissions in the ACT	Chapter 4 Outbreak of Gastrointestinal Illness	Chapter 5 Evaluation of the ACT General Health Survey	Chapter 6 Teaching Experience
Investigate an acute public health problem or threat (typically a disease outbreak);			✓		
Evaluate a surveillance system or other health information system				✓	
Analyse a public health dataset such as surveillance data	✓	✓			
Design and conduct an epidemiological study		✓			
Preparation of an advanced draft of a paper for publication in a national or international peer-reviewed journal	✓	✓			
A literature review that demonstrates skills in conducting a targeted literature search and synthesis		✓			
An abstract and oral presentation of the project at a scientific conference	✓				
A relevant report on the project to a non-scientific audience.				✓	
Prepare and deliver a lesson from the field (LFF)					✓
Prepare and conduct a case study for first year MAE students or other epidemiology training program					✓

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CHAPTER 1- Introduction

During the Master of Philosophy in Applied Epidemiology (MAE) program my field placement was with the Epidemiology Section, Health Improvement Branch, Population Health Protection and Prevention Division, ACT Health Directorate. A few highlights of my placement are detailed below.

Being the first MAE scholar placed in the Epidemiology Section has provided me with many opportunities to work on large datasets. The Epidemiology Section conducts population health monitoring and reporting for the ACT population. This is achieved through three primary activities: collecting, analysing and disseminating population health information. The Section also undertakes projects to examine emerging health issues; provides advice and assistance relating to research and evaluation; and conducts research related to key public health issues. Data collections used to perform these tasks include:

- ACT Health Survey Program (HSP) including the *ACT General Health Survey (GHS), ACT Year 6 Physical Activity and Nutrition Survey,* ACT component of *the Australian Secondary School Alcohol and Drug Survey* and *Kindy Screen*
- *ACT Cancer Registry*
- *ACT Maternal Perinatal Data Collection*
- *ACT Admitted Patient Care Collection (ACT APC)*
- *ACT Emergency Department Information System (EDIS)*

One of the motivations for conducting my MAE projects was to promote better use of these routinely-collected datasets to answer questions of public health importance for ACT Health. These datasets, particularly access to internally-linked individual-level data, enables sophisticated and informative analysis that goes beyond reporting of standard performance indicators, as demonstrated in my projects on Emergency Department (ED) use and hospital readmissions.

Working with the population health data, I have developed a broad understanding of the health issues and challenges in the ACT. Being a relatively

small jurisdiction, with a population of 409,141 persons as at 31 March 2017(1), ACT has seen positive and negative changes in population health outcomes. Over the past 20 years, the prevalence of overweight/obesity among adults increased from 40% (in 1995) to 63% (in 2014), while smoking prevalence decreased from 21% (in 1995) to 10% (in 2014). (2) About 80% of the burden of disease is attributable to chronic conditions, including heart disease, stroke, cancer, type 2 diabetes, obesity, and arthritis. (2) In 2013-2014, 41% of all potentially preventable hospitalisations were attributable to chronic diseases.(2)

In addition, ACT is facing high demands for health services from its residents. Like other jurisdictions, population aging continues to pose challenges on how health services are delivered. Cross-border flows remain an issue with Canberra being the major health referral centre for the Greater Southern Region of NSW. ACT also has a unique situation where diverse suburbs have high numbers of both the most and the least disadvantage individuals. SEIFI calculations (Socio-Economic Indexes for Individuals – a measure of relative socio-economic disadvantage) estimate that approximately 10% (40,400) of ACT residents experience high disadvantage. (3) Therefore, to ensure optimal delivery of existing health resources, we need to understand better where the demands are from this unique population to address their specific health and social needs.

I have developed valuable skills through the MAE program, including analysing linked hospital data and understanding population surveys. Having access to the hospital datasets through my placement, and expertise in health service research through ANU, made it possible to work on my projects. By using the internally-linked ACT APC and EDIS datasets in my analysis, I was able to differentiate between episodes of care and patients, enabling within-patient patterns of care to be analysed. By evaluating the ACT GHS, I obtained knowledge on how surveys work and issues and challenges in sampling and weighting. I have also gained some insights in the limits and difficulties in collecting and managing health data in the ACT. One of the important lessons I learnt was the timing of releasing data is critical which can be influenced by

many factors, including community sensitivities and ‘background noise’ from the media.

In addition, to fulfil the requirements of the MAE program, I also assisted the team at Communicable Disease Control (CDC) Section of ACT Health to investigate a gastroenteritis outbreak. It was a great experience to learn from and work with the colleagues at the CDC and switch my mind away from coding and analysing large datasets.

References:

1. Treasury and Economic Development. ACT’s Population up as at 31 March 2017. Canberra: 2017.
2. ACT Health. Healthy Canberra, Australian Capital Territory Chief Health Officer's Report 2016. Canberra ACT: ACT Government, 2016.
3. ACT Community Services Directorate. Detecting Disadvantage in the ACT: Report on the Comparative analysis of the SEIFI and SEIFA indexes of relative socio-economic disadvantage in the Australian Capital Territory. Canberra: ACT Government, 2012.

CHAPTER 2 - Factors associated with frequent Emergency Department use in the ACT

2.1 Prologue

2.1.1 Study rationale

The ACT Emergency Department Information System (EDIS) data collection is routinely used for performance monitoring and reporting by the Performance Information Branch in ACT Health. It is also routinely used by the Epidemiology Section (my work placement) to monitor and report trends on presentation conditions and types for a range of epidemiology reports. However, this is the first time the Epidemiology Section has obtained access to the full data collection of 2004-2014 and that the data have been used for linked-data analysis. At the time when I was looking for potential projects, there was a strong interest on frequent use of Emergency Department (ED) services from the public and ACT government. Concerns were raised that the existing ED resources could not keep up with the increasing demand from its users. Frequent ED use might also be an indicator for poor use of primary care or inappropriate ED planning. As part of the response to this, I undertook a project to study frequent users of ED services in the ACT.

2.1.2 My role

Rosemary Korda developed the concept for this project. I was responsible for project design. Hospital staff completed data collection as per routine practice. I developed the data analysis plan, conducted data analysis and interpretation of results. I prepared the draft manuscript and presented the project at an MAE seminar. Oscar Yang, the biostatistician in the Epidemiology Section, provided great assistance to help clean and set up the dataset for analysis. I also prepared all the ethics applications required for this project, including separate applications for ethics committees in ACT Health, ANU and Calvary Public Hospital.

2.1.3 Lessons learnt

This was the first time I had analytically and systematically worked with an administrative hospital dataset. I learnt what data items were collected and in

which format, how to work with ICD coding, and how to differentiate patient analysis from episode analysis. I realised how important it is to familiarise myself with the dataset when developing the analysis plan. I did this through talking to the data manager and other data users and using the data dictionary. Meanwhile, preparing a thorough data analysis plan is critical, even if some details might change later, as it helps to clarify project aims, methods and outcomes. The time spent on developing a good analysis plan is definitely time well invested.

This project provided me a great opportunity to develop my skills in using Stata. I enjoyed working with the biostatistician to understand and learn statistical techniques. I learnt how to recode variables, including the use of extended generate functions (e.g. “tag”), which are particularly useful for managing data with complex relations between individual person and multiple events. I found writing notes on Stata do files helped remember and justify the commands used in each step. I also learnt about how to conduct sensitivity analysis. It is interesting to see how different the approaches taken by epidemiologists and biostatisticians were to achieve the same outcomes. The questions asked by the biostatistician helped define and clarify details in coding the data.

Another important lesson I learnt was through preparing ethics applications. It was important to explain in detail about what data collection was to be used and whether there were potential risks of breaching patients’ privacy. I emphasised ‘the data to be used in my project have already been collected and the investigator would have no contact with the hospital or with patients’ to waive requirements of obtaining approvals from ED executives. I also managed to further understand and improve my data analysis plan in the process of preparing three different ethic applications. However, I was surprised that there were separate ethics applications required for each hospital where the data were collected. I hope this requirement could be simplified in the future.

2.1.4 Public Health Implications

To our knowledge, this project is the first study conducted to characterise frequent ED users in the ACT. It provides an overview and baseline for further

analysis on frequent users. In identifying patient and visit characteristics associated with frequent use, it can help policy makers and practitioners to develop targeted interventions to reduce ED crowding and address the needs of these patients in the ACT. For example, the finding that a high proportion of frequent users returned within one week, and with the same diagnosis as their previous visit, suggest, better follow-up in the community could potentially prevent some of these ED admissions. There may be benefits in discussing the findings and their potential application with clinicians. Unfortunately, such discussion was not possible at the time of this project.

2.1.5 Acknowledgements

I wish to acknowledge the following persons and organisations of their assistance with the data analysis: Rosemary Korda at the National Centre for Epidemiology and Population Health, ANU; and Oscar Yang, Bridget O'Connor, Hai Phung, Wayne Anderson, Rosalind Sexton and Leah Newman at the Epidemiology Section, ACT Health.

2.2 Abstract

Emergency Department (ED) use in the ACT continues to rise, however little is known about frequent users of these services. This study aimed to investigate characteristics associated with frequent ED users in the ACT.

This study was a secondary data analysis of the ACT Emergency Department Information System (EDIS). It included all patients who visited an ACT ED at least once between July 2013 and June 2015. Descriptive analyses were conducted to estimate the proportion of frequent ED users (≥4 visits in one year), and quantify the associations between patient and visit characteristics and frequent use using logistic regression, adjusting for age and sex.

Of the 143,912 ED users in the study, 6.6% (n=9,463) were frequent users, accounting for 21.9% (52,179/238,543) of the total ED visits. Among frequent users, abdominal and pelvic pain (6.7% of visits) was the most common reported principal diagnosis, and about one third of the ED visits occurred within 7 days of the last visit. All patient characteristics examined were significantly

associated with being a frequent user, including older age (aOR =2.26; 95% CI: 2.10-2.44 for age ≥80+ years compared to 25-44 years); and being female (aOR =1.11; 95% CI: 1.06-1.15); not married (aOR =1.45; 95% CI:1.38-1.53), without private health insurance (aOR=1.40; 95% CI = 1.33-1.46) and born in Australia vs not (aOR=1.06; 95% CI =1.01-1.11). For visit characteristics, most notable was that frequent users were more likely than non-frequent users to have visits lasting over 24 hours (aOR=2.23, 95%CI 2.03-2.45, compared to 0-4 hours), to leave the ED unattended (aOR= 1.28, 95% CI: 1.22-1.34),) or leave at own risk (aOR=2.04, 95%CI 1.87-2.22) compared to discharge without admission, and be referred by police, corrective or community services (aOR=1.53, 95%CI 1.50-1.57, compared to self-referral).

This study has identified a range of factors that are associated with being a frequent user in the ACT. Early identification and follow-up in the community for those patients will assist in the development of targeted strategies to improve health service delivery to this vulnerable group.

2.3 Introduction

Use of Emergency Department (ED) services has been rising in the ACT, as elsewhere in Australia. In 2014-15, there were a total of 129,961 ED visits in emergency departments in the ACT, with total visits increasing by an average of 3.7% per year since 2010-2011, similar to the national rate of 4.5%. (1) In other countries, including the United States, United Kingdom and Sweden, an estimated 1-5% of patients seen in the ED account for 12 to 18% of all annual ED visits. (2-7) Although there is no standard definition of what constitutes frequent ED use, when defined as 4 or more visits per year, a commonly used definition (2, 8), frequent users are reported to account for 4 to 8% of all ED patients and contribute 18 to 28% of all ED visits in Sweden and the United States. (2, 4) One Australian study reported the ED re-presentation rate within 28 days of discharge from hospital was 18% of visits and 14% of all patients. (9) To date, there are few reports on the prevalence of frequent ED users at either the national or state/territory level in Australia."

Several factors are found to be associated with frequent ED users, including being older, female, homeless, chronically ill, suffering mental illness, or having a history of substance misuse. (2, 8-14) Most of the frequent ED use studies focus on specific populations, such as elderly, paediatric and psychiatric patients. (15, 16) Factors associated with frequent ED in these studies included age, gender, race and ethnicity, and insurance status. (15, 16) However, little is known about the characteristics of frequent ED users in the ACT and their patterns of use over time. Most patients do not remain frequent users over time, (17-19) but there are few details on whether their visits occur over a short period (such as three visits spaced evenly over a month or a year) or cluster around particular events (such as an acute medical illness or a traumatic injury). (8)

The primary aim of this study was to quantify and characterise ED frequent users in the ACT. The objectives include to: describe numbers and proportions of frequent users and visits, and the pattern of ED use over time among frequent users; and to identify patient and visit characteristics that are associated with frequent ED use.

2.4 Methods

2.4.1 Data source and study sample

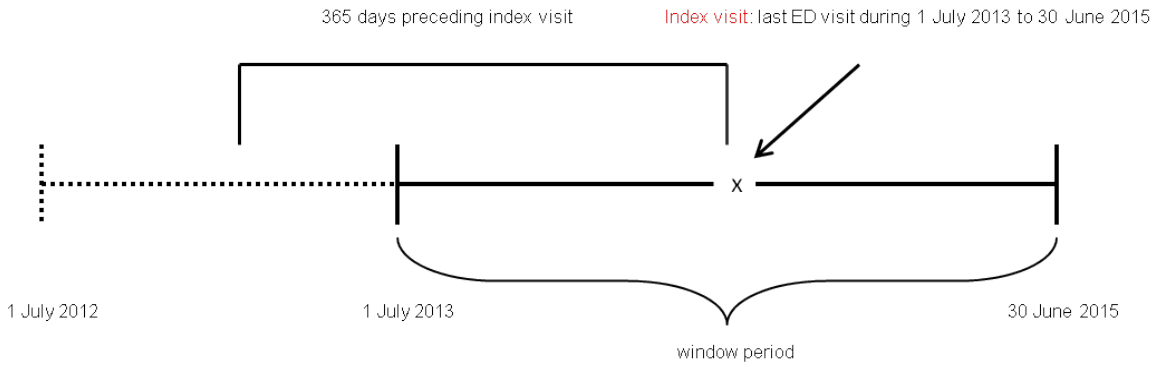
This study was a secondary data analysis of the ACT Emergency Department Information System (EDIS) data collection for the financial years 2012-13 to 2014-15 (i.e. 1 July 2012 to 30 June 2015). This data collection comprises information on ED visits from the two hospitals that provide ED services in the ACT — Canberra Hospital and Calvary Public Hospital. It includes a range of data items for each person who presents to the ED, including patient demographics and their visit characteristics. Patient registration numbers are used to internally link records, enabling within-patient patterns of use to be analysed. Between 2012-13 and 2014-15, there were 190,294 different individuals recorded as using ED services, totalling 374,013 visits. Participants for this study consisted of patients who visited the ED at least once between 1 July 2013 and 30 June 2015 (the window period).

2.4.2 Variables

Because the data were drawn from a routinely collected administrative dataset, most of the variables selected for our study had <1% missing data. The one exception was marital status (3.1% missing data).

ED user type - frequent/non-frequent user: The threshold used to define 'frequent ED users' ranges from 2 to 12 or more visits per year, (2, 11, 12, 20, 21) and no study has shown a threshold number at which big differences in resources, demographics, or clinical importance are observed. (2) For this study, we adopted the most commonly used threshold, 4 or more visits per year, (8) to define frequent users. To categorise patients as frequent or non-frequent users, each patient's most recent ED visit during the window period (referred to as the index ED visit) was identified and the number of ED visits in the 365 days prior to the index visit was counted (Figure 1). This count was then added to the index visit to create for each patient a measure of total ED visits in one year. Patients were subsequently classified as either frequent users (≥4 visits in the one year period) or non-frequent users (1-3 visits).

Figure 1. Schematic of strategy used to ascertain ED visit frequency in one year



Patient and visit characteristics: Socio-demographic variables, as recorded at the index admission, included: *age*, (0-4, 5-17, 18-24, 25-44, 45-64, 65-79, 80+ years); *sex* (male, female); *marital status* (married, not married); *hospital insurance* (yes, no); and *county of birth* (Australia, other). Visit variables included *primary diagnosis* (ICD-10-AM 3-character level); *time intervals between each visit*, calculated as time between consecutive visits (≤7 days, 8-30 days, 31-90 days, 91-180 days,181-365 days); *visit on weekend* (yes, no);

*arrival time (*8am-5pm,5.01pm-12 midnight,12.01am-7.59am); *visit season* (spring, summer, autumn, winter); *triage category* (non-urgent >30 mins, urgent <=30 mins); *length of stay*, calculated as departure time minus arrival time (0-4hr, 5-12hrs, 13-24hrs, 24+hrs), *visit outcome* (departed-no admission, admitted or referred to another hospital; did not wait to be attended; left at own risk; death), *source of referral* (self, family, friends; health care practitioner; police, corrective or community services; other); and *mode of arrival* (ambulance, other).

Analysis: The numbers and proportions of patients and visits were calculated by ED user type (frequent/non-frequent), for the total sample and separately in relation to patient and visit characteristics. The strength of association between ED user type and each of the characteristics was quantified using logistic regression, adjusting for age and sex, and adjusted odds ratios (aORs) were reported with their 95% confident intervals (CIs). For the analysis of socio-demographic factors, the unit of analysis was the person; and for the visit characteristics, the unit of the analysis was the visit. We also conducted a sensitivity analysis using different cut points for the definition of frequent users (≥3 visits and ≥7 visits). Results were reported by ICD-10-AM chapters and 3-character levels. (22) Data were analysed using Stata version 14.

Ethics approvals were granted from the Human Research Ethics Committees of the Australian National University (ANU), ACT Health and Calvary Health Care ACT Public.

2.5 Results

2.5.1 Sample population

The study sample comprised the 143,912 patients who visited ED at least once between 1 July 2013 and 30 June 2015. These patients made a total of 238,543 visits in the year prior to their index visit (mean visits per person in one year=1.7, SD =1.63). Approximately 75% of the study population comprised adults (≥18 years of age) with 16% of the total aged 65 years or older. Sex distribution was equal in the sample, and the majority were not married (59%),

did not have hospital insurance (≥61%), and were born in Australia (77%). (Table 1)

Table 1. Socio-demographic characteristics of study population

Socio-demographic characteristics	Patients		Visits	
	n	%	n	%
Age (years, at index visit)				
0-4	16,340	11	28,065	12
5-17	20,750	14	30,789	13
18-24	16,741	12	28,630	12
25-44	39,541	27	64,856	27
45-64	27,494	19	43,746	18
65-79	14,890	10	25,770	11
80+	8,156	6	16,687	7
Sex^				
male	72,247	50	117,503	49
female	71,662	50	121,034	51
Marital status#				
married	58,266	41	93,138	39
not married	84,556	59	143,819	61
Hospital insurance*				
yes	51,748	36	78,787	33
no	86,342	61	149,612	63
not known	4,416	3	7,700	3
Country of birth				
Australia	110,811	77	184,023	77
other	33,101	23	54,520	23
Total	**143,912**	**100**	**238,543**	**100**

Note: ^ <0.01% (n=3) missing data
0.8% (n=1090) missing data
*3.1% (n=4416) missing data

2.5.2 Proportion of frequent users

Of the 143,912 ED users in the study, 6.6% (n= 9,463) were categorised as frequent users. Frequent users accounted for 21.9% (52,179/238,543) of ED visits in the one year period of observation.

2.5.3 Patient characteristics associated with frequent users

The proportion of frequent users varied by age, ranging from 3.8% in those aged 5-17 years to 13.2% in those aged 80 years or more, and was slightly higher for females (7.0%) than males (6.2%). (Figure 2)

After adjustment for age and sex (where appropriate), all patient characteristics examined were significantly associated with being a frequent user; however, the absolute differences in the proportion of frequent users across sub-groups were small with the exception of age. The odds of being a frequent user was more than double among those aged ≥80 years compared to those aged 25-44 years (aOR =2.26; 95% CI = 2.10-2.44). Frequent users were also more likely to be female (aOR =1.11; 95% CI = 1.06-1.15), not married (aOR =1.45; 95% CI = 1.38-1.53), without private health insurance (aOR=1.40; 95% CI = 1.33-1.46) and born in Australia (aOR=1.06; 95% CI =1.01-1.11). (Table 2)

Figure 2. Proportion of frequent users within each age group by sex

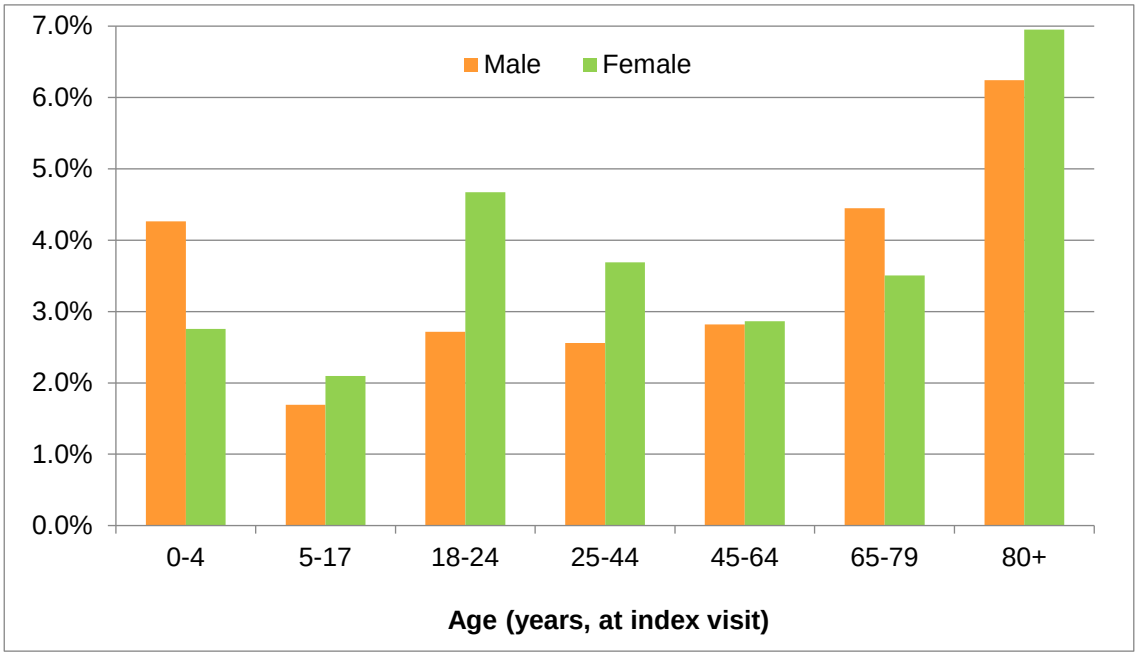


Table 2. Number and proportion of patients by ED user type (frequent vs non-frequent) in relation to patient characteristics, and age-sex adjusted odds ratios (aOR)

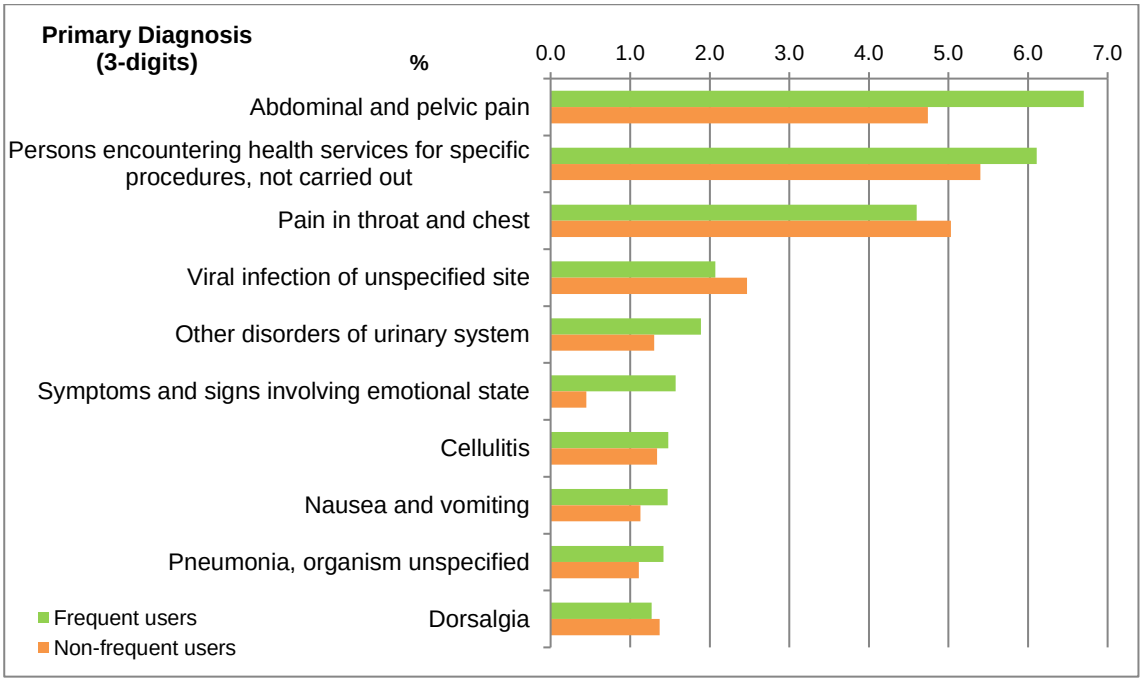
Patient characteristics	Frequent user		Non-frequent user		aOR	95%CI	p value
	N	%	N	%			
Age (years, at index visit)							
0-4	1,147	7.0	15,193	93.0	1.14	1.06-1.23	
5-17	786	3.8	19,964	96.2	0.59	0.55-0.65	
18-24	1,237	7.4	15,504	92.6	1.20	1.12-1.29	
25-44	2,470	6.3	37,071	93.7	1.00	-	<0.001
45-64	1,563	5.7	25,931	94.3	0.91	0.85-0.97	
65-79	1,184	8.0	13,706	92.0	1.30	1.21-1.39	
≥80	1,076	13.2	7,080	86.8	2.26	2.10-2.44	
Sex							
male	4,461	6.2	67,788	93.8	1.00	-	<0.001
female	5,002	7.0	66, 660	93.0	1.11	1.06-1.15	
Marital status							
married	3,467	6.0	54,799	94.0	1.00	-	<0.001
not married	5,982	7.1	78,574	92.9	1.45	1.38-1.53	
Private insurance							
yes	2,806	5.4	48,942	94.6	1.00	-	<0.001
no	6,432	7.5	79,910	92.5	1.40	1.33-1.46	
Country of birth							
other	2,239	6.8	30,682	93.2	1.00	-	<0.001
Australia	7,224	6.5	103, 587	93.5	1.06	1.01-1.11	
Total	**9,463**	**6.6**	**134,449**	**93.4**	-	-	-

2.5.4 Visit characteristics associated with frequent users

At the ICD chapter level, the top three group chapters were responsible for half of the ED visits by frequent users: s*ymptoms, signs not elsewhere classified*

(23.2%); injury, poisoning and certain other consequences of external causes (17.1%); and factors influencing health status and contact with health services (10.2%). Altogether, 1,111 different 3-character ICD-10-AM principal diagnoses were recorded across 238,504 visits made in the one year period of observation (39 missing diagnosis data). The 10 most common diagnoses were responsible for almost one-third of the total number of principal diagnoses reported (29% among frequent users, 28% among non-frequent users). Similar to non-frequent users, the most common reasons for visiting among frequent users were *abdominal and pelvic pain (6.7% of visits)*, followed by *persons encountering health services for specific procedures*, *not carried out* (6.1%) and *pain in throat and chest* (4.6%) (Figure 3). Notably, *pneumonia, organism unspecified* and *symptoms and signs involving emotional state* were within the top 10 diagnosis reported by frequent users. These contrasts to *dislocation, sprain and strain of joints and ligaments at ankle and foot level* and *other gastroenteritis and colitis of infectious and unspecified origin* by non-frequent users.

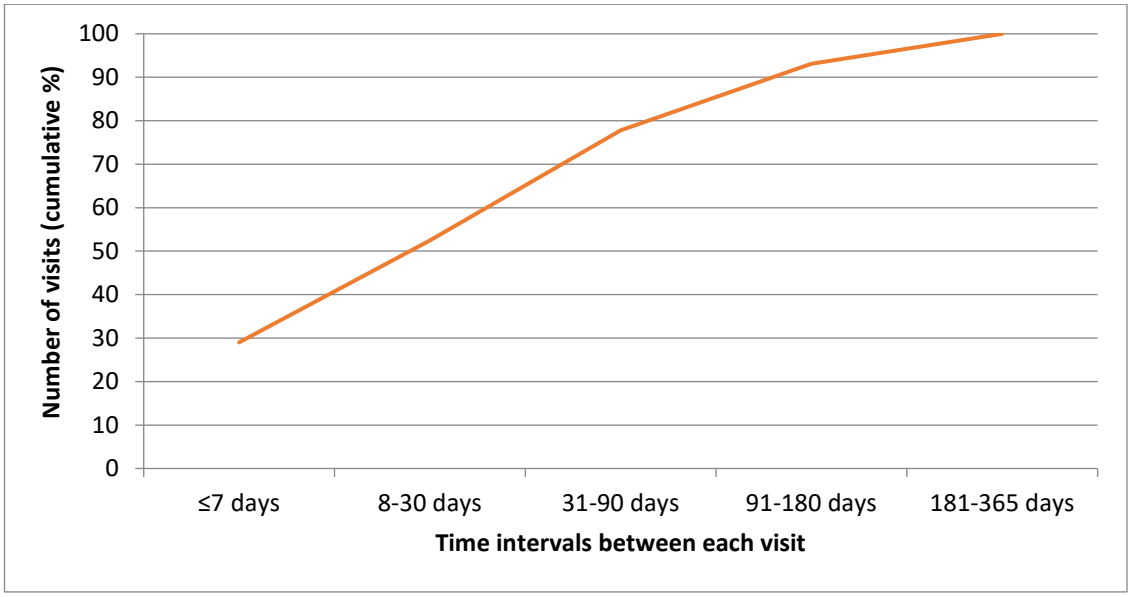
Figure 3. Proportions of ED visits by the 10 most common principal diagnoses (ICD-10-AM 3-character level), separately for frequent and non-frequent users



Approximately 30% (n=12,394) of the ED visits made by frequent users occurred within 7 days of the last visit, with half (52%) made within 30 days.

(Figure 4) Among the visits within a one week interval, 41% (n=5,075) had the same diagnosis as their last visit.

Figure 4. Time Intervals between each visit by frequent users



All visit characteristics examined were significantly associated with user type, except the visit season. The most notable associations were found with length of episode, visit outcome, source of referral and mode of arrival. (Table 3) The proportion of total visits made by frequent users increased with increasing length of episode (19.2% of the visits lasting 0-4 hours compared to 34.3% of the visits lasting 13-24 hours (aOR=1.89, 95%CI 1.81-1.97) and 38.9% of those lasting over 24 hours (aOR=2.23, 95%CI 2.03-2.45). The vast majority of both frequent and non-frequent users were discharged without being admitted, among which 19.6% were attributed to frequent users; however frequent users were more likely than non-frequent users to leave the ED unattended (23.6% of these visit types were made by frequent users; aOR= 1.28, 95% CI: 1.22-1.34, compared to discharge without admission) or leaving at their own risk (33.6% involving frequent users; aOR=2.04, 95%CI 1.87-2.22). The majority of patients were self-referred, with frequent users accounting for 20.2% of these referral types. In comparison, only 17.1% of the health-care referred visits but 30.6% of visits referred by police, corrective or community services were made by

frequent users (aOR=0.79, 95%CI: 0.76-0.82 and aOR=1.53, 95%CI 1.50-1.57compared to self-referral, respectively),

Table 3. Number and proportion of visits by ED user type (frequent vs non-frequent) in relation to visit characteristics, and age-sex adjusted odds ratios (aOR)

Visit characteristics	Frequent user visits		Non-frequent user visits		aOR	95%CI	p value
	N	%	N	%			
Visit on weekend							
no	38,022	22.3	132,679	77.7	1.00	-	-
yes	14,157	20.9	53,685	79.1	0.93	0.91-0.95	<0.001
Arrival time							
8am-5pm	29,714	21.6	107,862	78.4	1.00	-	-
5.01pm-12 midnight	14,657	21.6	53,115	78.4	1.04	1.01-1.06	<0.001
12.01am-7.59am	7,808	23.5	25,387	76.5	1.11	1.08-1.14	
Visit season							
Spring	12,023	21.5	43,952	78.5	1.00	-	-
Summer	12,996	22.2	45,444	77.8	1.04	1.01-1.07	
Autumn	14,246	21.9	50,726	78.1	1.03	1.00-1.06	0.084
Winter	12,914	21.8	46,242	78.2	1.02	0.99-1.05	
Triage category							
non-urgent >30 mins	26,273	19.6	108,103	80.4	1.00	-	-
urgent <=30 mins	25,906	24.9	78,261	75.1	1.28	1.25-1.31	<0.001
Length of episode							
0-4 hr	28,734	19.2	120,834	80.8	1.00	-	-
5-12hr	19,042	24.9	57,356	75.1	1.31	1.28-1.33	
13-24hr	3,648	34.3	6,989	65.7	1.89	1.81-1.97	<0.001
24+hr	748	38.9	1,174	61.1	2.23	2.03-2.45	
Visit outcome							
Departed-no admission	30,452	19.6	125,169	80.4	1.00	-	-
Admitted or referred to another hospital	17,940	26.4	49,938	73.6	1.30	1.27-1.33	<0.001

Did not wait to be attended	2,936	23.6	9,479	76.4	1.28	1.22-1.34	
left at own risk	831	33.6	1,640	66.4	2.04	1.87-2.22	
Death	20	12.7	138	87.3	0.45	0.28-0.72	
Source of referral							
Self, family, friends	34,486	20.2	135,828	79.8	1.00	-	-
Health care practitioner or facility	4,091	17.1	19,769	82.9	0.79	0.76-0.82	
Police, corrective or community services	13,289	30.6	30,083	69.4	1.53	1.50-1.57	<0.001
Other	313	31.4	684	68.6	1.74	1.52-1.99	
Mode of arrival							
Other	38,507	20.1	152,817	79.9	1.00	-	-
Ambulance	13,672	29.0	33,547	71.0	1.41	1.38-1.45	<0.001
Total	**52,179**	21.9	**186,364**	78.1	-	-	-

*Note: frequent user is defined 4 or more visits per year.

2.5.5 Sensitivity analysis

We conducted sensitivity analyses, using different thresholds to define 'frequent users': ≥3 visits and ≥7 visits. Using ≥3 visits as the cut-off point, frequent users accounted for 14.2% of total ED users and contributed 35.7% in the total visits. Using ≥7 visits as the cut-off point, only 1.2% patients were classified as frequent users, and they accounted for 7.0% of the total visits. Associations with the patient and visit characteristics were similar whether a frequent user was defined by ≥3 visits per year or ≥7 visits per year. However, several variables, (length of episode, visit outcome, source of referral and mode of arrival) had stronger associations with frequent use when using ≥7 visits per year as cut-off point than ≥4 visits per year. Results of sensitivity analysis are provided in Appendix 2.

2.6 Discussion

To our knowledge, this is the first study to quantify and characterise ED frequent users in the ACT, finding 6.6% of ED users were frequent users, accounting for 21.9% of the total ED visits. Among frequent users, abdominal and pelvic pain was the most common reported principal diagnosis (which is

also commonly reported in non-frequent users), and about one third of the ED visits occurred within 7 days of the last visit. Our analysis showed that the risk of frequent ED use increased with being female, not married, without private health insurance, length of episode, visit outcome, source of referral or mode of arrival.

Our findings are consistent with previous studies on patient and visit characteristics of frequent users. The tendency for frequent users to be older, female, single or with pain-related conditions as primary diagnoses found in this study have been reported previously. (2, 8, 12, 13, 18, 21, 23) Elderly people are known to have poorer health status, with a need for more medical or psychosocial support. Similar to other studies (5, 13, 14, 18, 24, 25), we also found visits of frequent users were more likely than those of non-frequent users to be referred by police, corrective or community services, to involve arrival by ambulance, and to result in not waiting to be assessed or the patient leaving at their own risk. Socioeconomic difficulties including homelessness, alcoholism, illicit drug abuse and mental disorders are known to be associated with frequent ED use. (5, 19, 25, 26) Arrival by ambulance suggests that frequent users are generally sicker than non-frequent users, as they were reported more likely to be admitted or die in the ED. (2, 10, 18) Our finding that the percentage of the visits made by frequent users increased with increasing length of episode also suggests that frequent users are generally sicker than non-frequent users.

In addition, we investigated visit intervals of frequent users and their visiting reasons, which are not commonly reported in other studies. This study found around one third of frequent users returned within 7 days, with 41% of their visits having the same diagnosis as the last visit. The interval finding was consistent with an earlier study which found re-presentation rates within 28 days of discharge from hospital cluster around one week after discharge and rapidly decrease thereafter.(9) This might indicate potential issues in further referral or access to primary care as evidence suggests that frequent ED users have complex healthcare needs and are heavy users of all type of care including the general practice services. (2-7, 10, 12) In 2015-16, there are 523 head count of

full-time service equivalent GPs in the ACT (27), about 0.78 per 1000 people on average (estimated 409,141 persons as at 31 March 2017 (28)). Interventions aimed at reducing the number of ED visits by frequent users, including case management, individualised care plans and information sharing, have been evaluated but evidence is inconclusive. (29)

Limitations of this study include that we were unable to investigate social and economic characteristics of frequent users, which are known to influence service use such as socioeconomic status, race, alcohol dependence, and homelessness. (30-34) Although the Socio-Economic Indexes for Areas (SEIFA) index, is commonly used as a proxy measure of socioeconomic status, it is not suitable as a tool to estimate individual socio-economic status of ACT residents. (35) One of the strengths of this study is that unlike other studies that use a calendar-based timeline to measure visit frequency, (10, 11, 19, 36) we used individual patient-based timelines to analyse associated factors to ensure each patient was given an equal observation period. This study also contributes to the existing evidence on the patterns of use by frequent users including time intervals between each visit and visiting reasons. Moreover, the dataset we used in this study captured all the ED visits, which enables us to study the whole population of ED users in the ACT, not specific populations such as paediatric and psychiatric patients. (15, 16)

2.7 Conclusion

This study uses existing information that are routinely collected by the EDIS to investigate socio-demographic and visit characteristics that are associated with frequent ED use in ACT public hospitals. Early identification and appropriate referrals for frequent users can assist in understanding their healthcare needs and the development of targeted strategies to improve health service delivery to this vulnerable group. As access to care emerges as a key issue underlying frequent ED use in the literature, it would be helpful to assess the availability and quality of current programs and services, including continuity and coordination of primary care within the community.

2.8 Appendices

Appendix 1. Number and proportion of ED users by frequency of use for each financial year from 2012-13 to 2014-15

Visit Frequency	2012-13		2013-14		2014-15		Total	
	N	%	**N**	%	**N**	%	**N**	**%**
1	57,119	72.28	59,424	71.89	61,538	71.93	178,081	**72.03**
2	13,892	17.58	14,469	17.5	15,149	17.71	43,510	**17.6**
3	4,322	5.47	4,781	5.78	4,839	5.66	13,942	**5.64**
4	1,849	2.34	1,931	2.34	1,912	2.23	5,692	**2.3**
5	824	1.04	860	1.04	877	1.03	2,561	**1.04**
6	377	0.48	450	0.54	459	0.54	1,286	**0.52**
7	218	0.28	217	0.26	247	0.29	682	**0.28**
8	114	0.14	148	0.18	146	0.17	408	**0.17**
9-11	172	0.22	201	0.24	222	0.26	595	**0.24**
12-14	61	0.08	75	0.09	70	0.08	206	**0.08**
15-17	22	0.03	29	0.04	37	0.04	88	**0.04**
>=18	58	0.07	72	0.09	57	0.07	187	**0.08**
Total	**79,028**	**100**	**82,657**	**100**	**85,553**	**100**	**247,238**	**100**

Appendix 2. Proportion of patients by ED user type (frequent vs non-frequent) in relation to patient characteristics, and age-sex adjusted odds ratios (aOR), with frequent use defined as ≥3 times a year

Patient characteristics	Frequent user	Non-frequent user	aOR	95%CI	p value
Age (years, at index visit)					
0-4	16.2	83.8	1.24	1.18-1.31	
5-17	10.1	89.9	0.72	0.68-0.76	
18-24	15.1	84.9	1.13	1.08-1.19	
25-44	13.6	86.4	-		<0.001
45-64	12.2	87.8	0.89	0.85-0.93	
65-79	16.2	83.8	1.23	1.17-1.29	
≥80	25.4	74.6	2.16	2.04-2.28	
Sex					
male	13.5	86.5	-		<0.001
female	14.9	85.1	1.10	1.07-1.13	
Marital status					
married	13.1	86.9	-		<0.001
not married	15.1	84.9	1.33	1.29-1.38	
Private insurance					
yes	12.5	87.5	-		<0.001
no	15.5	84.5	0.98	0.97-0.99	
Country of birth					
other	14.2	85.8	-		<0.001
Australia	14.4	85.6	0.96	0.92-0.99	

Appendix 3. Proportion of visits by ED user type (frequent vs non-frequent) in relation to visit characteristics, and age-sex adjusted odds ratios (aOR), with frequent use defined as ≥3 times a year

Visit characteristics Visit on weekend	Frequent user visits	Non-frequent user visits	aOR	95%CI	p value
no	22.3	77.7	-	-	-
yes	20.9	79.1	0.91	0.89-0.93	<0.001
Arrival time					
8am-5pm	21.6	78.4	-	-	-
5.01pm-12 midnight	21.6	78.4	0.99	0.97-1.00	<0.001
12.01am-7.59am	23.5	76.5	1.09	1.06-1.11	
Visit season					
Spring	21.5	78.5	-	-	-
Summer	22.2	77.8	1.02	0.99-1.04	
Autumn	21.9	78.1	1.04	1.01-1.06	0.030
Winter	21.8	78.2	1.02	0.99-1.04	
Triage category					
non-urgent >30 mins	19.6	80.5	-	-	-
urgent <=30 mins	24.9	75.1	1.22	1.20-1.24	<0.001
Length of episode					
0-4 hr	19.2	80.8	-	-	-
5-12hr	24.9	75.1	1.27	1.24-1.29	
13-24hr	34.3	65.7	1.77	1.70-1.85	<0.001
24+hr	38.9	61.1	2.19	2.00-2.40	
Visit outcome					
Departed-no admission	19.6	80.4	-	-	-

Admitted or referred to another hospital	26.4	73.6	1.28	1.26-1.31	
Did not wait to be attended	23.7	76.4	1.19	1.15-1.24	<0.001
left at own risk	33.6	66.4	1.79	1.65-1.94	
Death	12.7	87.3	0.7	0.50-0.98	
Source of referral					
Self, family, friends	20.3	79.8	-	-	-
Health care practitioner or facility	17.2	82.9	0.8	0.77-0.82	
Police, corrective or community services	30.6	69.4	1.35	1.32-1.38	<0.001
Other	31.4	68.6	2.21	1.95-2.50	
Mode of arrival					
Other	20.1	79.9	-	-	-
Ambulance	29.0	71.1	1.25	1.22-1.28	<0.001

Appendix 4. Proportion of patients by ED user type (frequent vs non-frequent) in relation to patient characteristics, and age-sex adjusted odds ratios (aOR), with frequent use defined as ≥7 times a year

Patient characteristics	Frequent user	Non-frequent users	aOR	95%CI	p value
Age (years, at index visit)					
0-4	0.8	99.2	0.69	0.57-0.84	
5-17	0.4	99.6	0.37	0.29-0.46	
18-24	1.5	98.5	1.29	1.10-1.50	
25-44	1.2	98.8	-		<0.001
45-64	1.1	98.9	0.93	0.80-1.07	
65-79	1.5	98.5	1.27	1.08-1.49	
≥80	2.6	97.4	2.19	1.85-2.58	
Sex					
male	1.0	99.0	-		<0.001
female	1.3	98.7	1.20	1.09-1.32	
Marital status					
married	1.0	99.0	-		<0.001
not married	1.3	98.7	2.01	1.79-2.25	
Private insurance					
yes	0.8	99.2	-		<0.001
no	1.4	98.6	0.99	0.95-1.03	
Country of birth					
other	1.2	98.8	-		<0.001
Australia	1.1	98.9	0.78	0.69-0.88	

Appendix 5. Proportion of visits by ED user type (frequent vs non-frequent) in relation to visit characteristics, and age-sex adjusted odds ratios (aOR), with frequent use defined as ≥7 times a year

Visit characteristics	Frequent user visits	Non-frequent user visits	aOR	95%CI	p value
Visit on weekend					
no	7.2	92.8	-	-	-
yes	6.7	93.3	0.94	0.91-0.97	<0.001
Arrival time					
8am-5pm	6.6	93.4	-	-	-
5.01pm-12 midnight	7.4	92.6	1.12	1.15-1.23	<0.001
12.01am-7.59am	8.1	91.9	1.24	1.18-1.30	
Visit season					
Spring	7.0	93.0	-	-	-
Summer	7.2	92.8	1.02	0.97-1.06	
Autumn	7.0	93.0	1.01	0.97-1.06	0.030
Winter	6.9	93.1	0.99	0.95-1.04	
Triage category					
non-urgent >30 mins	6.0	94.0	-	-	-
urgent <=30 mins	8.3	91.7	1.35	1.31-1.40	<0.001
Length of episode					
0-4 hr	5.8	94.2	-	-	-
5-12hr	8.3	91.7	1.36	1.31-1.41	
13-24hr	13.1	86.9	2.05	1.92-2.18	<0.001
24+hr	14.8	85.2	2.29	2.01-2.60	
Visit outcome					
Departed-no admission	5.9	94.1	-	-	-

Admitted or referred to another hospital	8.8	91.2	1.32	1.28-1.37	
Did not wait to be attended	9.0	91.0	1.63	1.52-1.73	<0.001
left at own risk	17.0	83.0	3.01	2.70-3.35	
Death	1.9	98.1	0.24	0.08-0.76	
Source of referral					
Self, family, friends	5.9	94.1	-	-	-
Health care practitioner or facility	4.6	95.4	0.79	0.74-0.84	
Police, corrective or community services	12.9	87.1	2.18	2.10-2.26	<0.001
Other	8.2	91.8	1.36	1.08-1.71	
Mode of arrival					
Other	5.9	94.1	-	-	-
Ambulance	11.7	88.3	1.96	1.89-2.03	<0.001

Appendix 6. MAE seminar presentation – 5 September 2017, ANU

Factors associated with frequent emergency department use in the ACT

By Cecilia Xu
MAE Scholar, Australian National University
Filed placement with Epidemiology Section, ACT Health

ACT Government Health

Australian National University

Background

- Emergency department (ED) use in the ACT continues to rise, however little is known about the frequent users and their patterns of use
- In the U.S., UK and Sweden, an estimated1-5% of patients responsible for 12-18% of all visits. (Soril L et al).
- Known factors associated with frequent ED use
  - Being older, female, homeless, chronically ill
  - mental illness, history of substance misuse
- Definition of frequent users
  - No consensus in literature
  - 4 or more times a year commonly used

Aim and objectives

- Main questions
  - Who are frequent ED users in the ACT?
  - When, how and why do they use ED services?
- Aim: quantify and characterise frequent ED users in the ACT
- Objectives
  - Describe numbers and proportions of frequent users and their visits; pattern of ED use over time
  - Identify patient and visit characteristics that are associated with frequent ED use

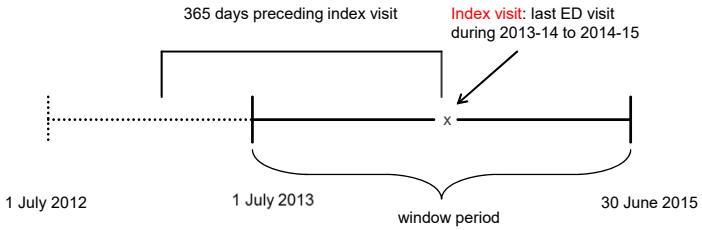
Methods

Data source and study sample

- Secondary analysis
- ACT Emergency Department Information System (EDIS) data collection
  - Canberra Hospital and Calvary Public Hospital
  - Include patient demographics and visit characteristics
  - Patient registration numbers used to internally link records
  - A total of 190,294 different individuals with 374,013 ED visits between 1 July 2012 and 30 June 2015 (study period)
- Participants consisted of patients who visited the ED at least once between 1 July 2013 and 30 June 2015 (the window period)

Methods

How to count visit frequency for each patient?



Methods

Analysis

- Descriptive analyses on numbers and proportions by ED user type (frequent/non-frequent), separately by patient and visit characteristics
- Logistic regression to assess strength of association between ED user type and each characteristic
- Age and sex adjusted odds ratios, 95% confident intervals
- Patient characteristics – analysis unit: person
- Visit characteristics – analysis unit: visit
- Stata 14 and Excel

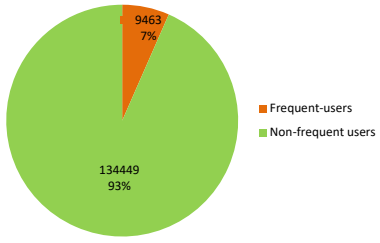
Results - Sample population

Socio-demographic characteristics	Patients	Visits
	%	%
Age (years, at index visit)		
0-4	11	12
5-17	14	13
18-24	12	12
25-44	27	27
45-64	19	18
65-79	10	11
80+	6	7
Sex		
male	50	49
female	50	51
Marital status		
married	41	39
not married	59	61
Hospital insurance		
yes	36	33
no	61	63
Not known	3	3
Country of birth		
Australia	77	77
other	23	23

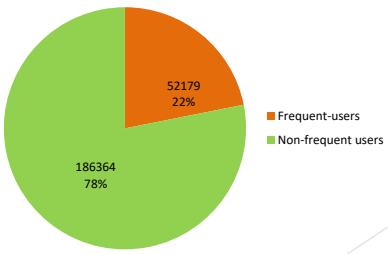
mean visits per person in one year=1.7

Results - Proportion of frequent users and visits

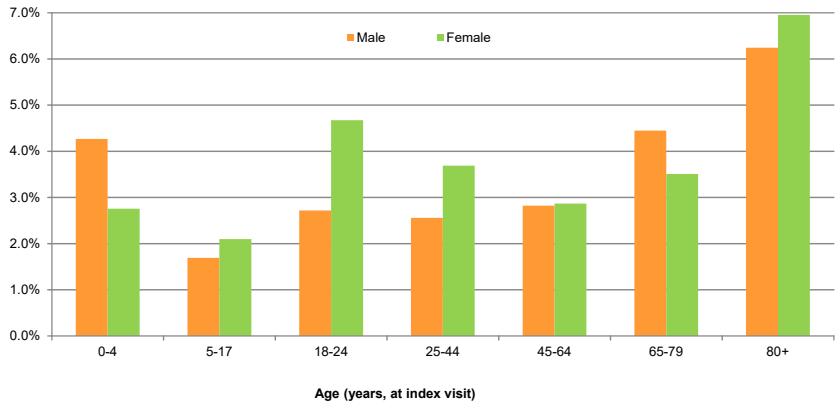
Number and proportion of patients



Number and proportion of visits



Results - Proportion of frequent users within each age group by sex



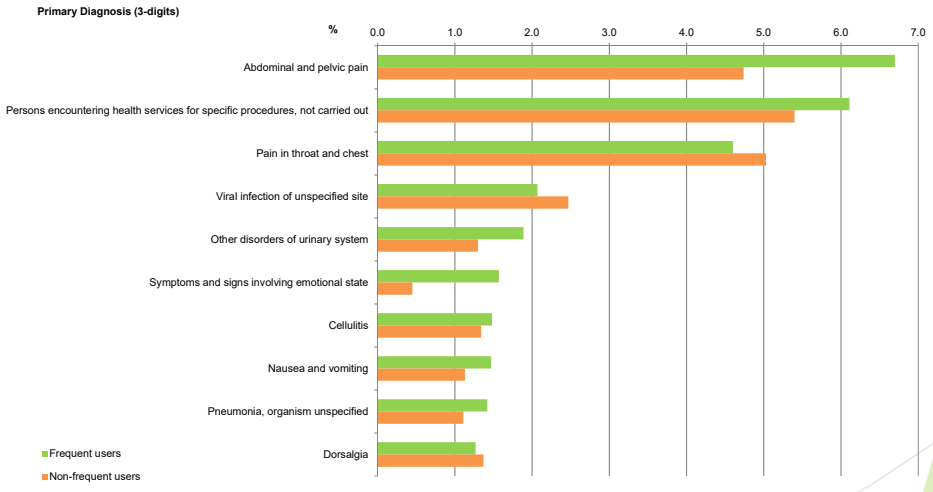
Results- Patient characteristics and adjusted OR

Patient characteristics	Frequent users %	aOR	95%CI	p value
Age (years, at index visit)				
0-4	7.0	1.14	1.06-1.23	<0.001
5-17	3.8	0.59	0.55-0.65	
18-24	7.4	1.20	1.12-1.29	
25-44	6.3	1.00	-	
45-64	5.7	0.91	0.85-0.97	
65-79	8.0	1.30	1.21-1.39	
≥80	13.2	2.26	2.10-2.44	
Sex				
male	6.2	1.00	-	<0.001
female	7.0	1.11	1.06-1.15	
Marital status				
married	6.0	1.00	-	<0.001
not married	7.1	1.45	1.38-1.53	
Private hospital insurance				
yes	5.4	1.00	-	<0.001
no	7.5	1.40	1.33-1.46	
Country of birth				
other	6.8	1.00	-	<0.001
Australia	6.5	1.06	1.01-1.11	

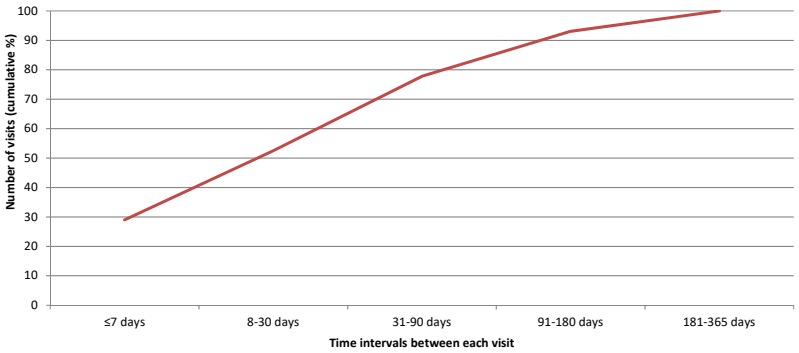
Results- Patient characteristics and adjusted OR

Patient characteristics	Frequent users %	aOR	95%CI	p value
Age (years, at index visit)				
0-4	7.0	1.14	1.06-1.23	<0.001
5-17	3.8	0.59	0.55-0.65	
18-24	7.4	1.20	1.12-1.29	
25-44	6.3	1.00	-	
45-64	5.7	0.91	0.85-0.97	
65-79	8.0	1.30	1.21-1.39	
≥80	13.2	2.26	2.10-2.44	
Sex				
male	6.2	1.00	-	<0.001
female	7.0	1.11	1.06-1.15	
Marital status				
married	6.0	1.00	-	<0.001
not married	7.1	1.45	1.38-1.53	
Private hospital insurance				
yes	5.4	1.00	-	<0.001
no	7.5	1.40	1.33-1.46	
Country of birth				
other	6.8	1.00	-	<0.001
Australia	6.5	1.06	1.01-1.11	

Results - Proportions of ED visits by the 10 most common principal diagnoses (ICD-10-AM 3-character level)



Result - Time Intervals between each visit by frequent users



Around one third of frequent users returned within 7 days, with 41% of their visits having the same diagnosis as the last visit.

Results - Visit characteristics and adjusted OR (cont.)

Visit characteristics	Frequent user visits %	aOR	95%CI	p value
Visit on weekend				
no	22.3	1.00	-	-
yes	20.9	0.93	0.91-0.95	<0.001
Arrival time				
8am-5pm	21.6	1.00	-	-
5.01pm-12 midnight	21.6	1.04	1.01-1.06	<0.001
12.01am-7.59am	23.5	1.11	1.08-1.14	
Visit season				
Spring	21.5	1.00	-	-
Summer	22.2	1.04	1.01-1.07	0.084
Autumn	21.9	1.03	1.00-1.06	
Winter	21.8	1.02	0.99-1.05	
Triage category				
non-urgent >30 mins	19.6	1.00	-	-
urgent<=30 mins	24.9	1.28	1.25-1.31	<0.001
Length of episode				
0-4 hr	19.2	1.00	-	-
5-12hr	24.9	1.31	1.28-1.33	<0.001
13-24hr	34.3	1.89	1.81-1.97	
24+hr	38.9	2.23	2.03-2.45	

Results - Visit characteristics and adjusted OR

Visit Outcome				
Departed-no admission	19.6	1.00	-	-
Admitted or referred to another hospital	26.4	1.30	1.27-1.33	<0.001
Did not wait to be attended	23.6	1.28	1.22-1.34	
left at own risk	33.6	2.04	1.87-2.22	
Death	12.7	0.45	0.28-0.72	
Source of referral				
Self, family, friends	20.2	1.00	-	-
Health care practitioner or facility	17.1	0.79	0.76-0.82	<0.001
Police, corrective or community services	30.6	1.53	1.50-1.57	
Other	31.4	1.74	1.52-1.99	
Mode of arrival				
Other	20.1	1.00	-	-
Ambulance	29.0	1.41	1.38-1.45	<0.001

Results - Visit characteristics and adjusted OR (cont.)

Visit characteristics	Frequent user visits %	aOR	95%CI	p value
Visit on weekend				
no	22.3	1.00	-	-
yes	20.9	0.93	0.91-0.95	<0.001
Arrival time				
8am-5pm	21.6	1.00	-	-
5.01pm-12 midnight	21.6	1.04	1.01-1.06	<0.001
12.01am-7.59am	23.5	1.11	1.08-1.14	
Visit season				
Spring	21.5	1.00	-	-
Summer	22.2	1.04	1.01-1.07	0.084
Autumn	21.9	1.03	1.00-1.06	
Winter	21.8	1.02	0.99-1.05	
Triage category				
non-urgent >30 mins	19.6	1.00	-	-
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Length of episode				
0-4 hr	19.2	1.00	-	-
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Other	20.1	1.00	-	-
Ambulance	29.0	1.41	1.38-1.45	<0.001

Discussion

- First study to quantify and characterise ED frequent users in the ACT (7% of patients and 22% of visits)
- Consistent with previous studies on patient and visit characteristics of frequent users: older, female, single or having pain-related conditions.
- Limitations
  - unable to investigate socio-economic and behavioural factors that were known to influence service use e.g. SES, race, alcohol dependence, and homelessness
- Strength
  - used individual patient-based timelines, instead of a calendar-based timeline, to measure visit frequency
  - investigated visit intervals and visiting reasons - not commonly reported in other studies.

Conclusion

- A range of patient and visit characteristics are associated with frequent use of ED services in ACT.
- A high proportion of frequent users returning within one week for same diagnosis highlights the need to enhance continuity of care and easy access to care when needed.
- Early identification and appropriate referrals for these frequent users might help relieve the increasing demands for ED services.

Acknowledgement

- Dr Rosemary Korda, MAE supervisor, ANU
- Dr Oscar Yang, Biostatistician, ACT Health
- Dr Hai Phung, field supervisor, ACT Health
- Ms Bridget O'Connor, field supervisor, Queensland Health
- MAE program, ANU
- Epidemiology Section, ACT Health

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CHAPTER 3 - 30-day unplanned readmissions in the ACT: rates, burden, and predictors

3.1 Prologue

3.1.1 Study rationale

The ACT Admitted Patient Care (APC) Collection is routinely used for performance monitoring and reporting by the Performance Information Branch in ACT Health. It is also routinely used by the Epidemiology Section (my placement) to monitor and report on trends in presentation conditions and presentation types by the ACT population for a range of epidemiology reports. However, this is the first time the Epidemiology Section has obtained access to the full data collection of 2004-2014 and that the data have been used for linked-data analysis.

While reducing unplanned hospital readmission rates have been identified as a key area for healthcare systems to improve patient outcomes and reduce healthcare costs, currently little is known about unplanned readmissions in the ACT. Prior to this study, we did not know what conditions have the highest readmission rates, nor which contribute most to the overall burden of readmission. Further, little is known regarding factors that are associated with unplanned readmission across a range of conditions and in the ACT context.

3.1.2 My role

Rosemary Korda developed the concept for this project. I designed the project, with input from my supervisors. I conducted a literature review on the subject and developed a project proposal. Oscar Yang, the biostatistician in my placement, contributed greatly in developing the methods and setting up the dataset for analysis. Rosemary and I had numerous discussions on how to conduct the study and report the results, such as how to identify and differentiate readmission from admissions and how to group the diagnosis coding. I conducted the analysis on my own, summarised the results and drafted the chapter. I also prepared all the ethics applications required for this project, including separate applications for ethics committees in ACT Health, ANU and Calvary Public Hospital.

3.1.3 Lessons learnt

This project provided a good opportunity to develop my skills on how to work on a large dataset and analyse administrative data. I learnt that details matter a great deal in every step, especially when cleaning and setting up the dataset for analysis. Questions leading to discussions included: how to identify unplanned from planned, how to deal with transfers within and between hospitals, and who to exclude in our study population.

One of the challenges I had was how to group diagnoses for reporting purposes. Although the International Classification of Diseases 10th revision – Australian Modification (ICD-10-AM) 3-characters or chapters were commonly used by others, we found they were either too specific or abroad to achieve meaningful results. Therefore, we adopted a tool that was in the between for this study.

I also found that reviewing methods used in similar studies and developing a project proposal as detailed as possible helped to answer questions. Moreover, flow charts were very useful to explain and work with others. For example, I developed a flow chart to show the biostatistician how to identify whether an admission had a readmission. We tested the flow chart in a small proportion of the dataset, and manually checked if the results met our criteria before applying onto the full dataset. The flow chart had been used as a reference every time we were unsure about the answers.

3.1.4 Public Health Implications

This study provides insight into all-cause unplanned readmission rates, instead of restricting to a limited number of specific diseases. The ranking provides evidence to identify and target conditions responsible for high readmission rates and burden in public hospitals in the ACT for further investigation. The findings could help identify opportunities to improve quality, target resources more efficiently, and reduce potentially preventable readmissions. There may be benefits in discussing the findings and their potential application with clinicians. Unfortunately, such discussion was not possible at the time of this project.

3.1.5 Acknowledgements

I wish to acknowledge the following persons and organisations of their assistance with the project: Rosemary Korda at the National Centre of Epidemiology and Population Health, ANU; and Oscar Yang, Bridget O'Connor, Hai Phung, Wayne Anderson, Rosalind Sexton, and Leah Newman at the Epidemiology Section, ACT Health.

3.2 Abstract

While reducing unplanned hospital readmission rates has been acknowledged to improve patient outcomes and reduce healthcare costs, currently little is known about unplanned readmissions in the ACT. The primary aim of this study was to examine which conditions have the highest rates of readmission and contribute most to 30-day unplanned readmissions in the ACT, and which patient characteristics are associated with readmissions.

This study was a secondary data analysis of the public hospital ACT Admitted Patient Care (APC) Collection. Participants of the study included all patients who had at least one admission at a Canberra public hospital between 1 July 2012 and 30 June 2015. Descriptive analyses were conducted to calculate readmission rates for each condition based on the primary diagnosis. We also conducted logistic regression to quantify the strength of association between the risk of unplanned admission and patient characteristics.

We identified an overall 30-day unplanned readmission rate of 6.2% across all included conditions, 7.8% among medical admissions and 3.9% among surgical admissions. However, for some conditions the readmission rates were relatively high, including for *liver disease, alcohol-related (19.2%); chronic obstructive pulmonary disease (16.1%); congestive heart failure, non-hypertensive (15.3%); heart valve disorders (17.4%); and other gastrointestinal disorders (11.9%).* Our analysis showed that the risk of unplanned admission increased with age and comorbidity.

For some conditions the rates were relatively high, suggesting areas to target for reducing readmissions. Older age and comorbidities are strong predictors for 30-day unplanned readmissions. Therefore, when developing preventative strategies and post-discharge plans, particular consideration should be given to patients at older age or with underlying comorbidities.

3.3 Introduction

Unplanned readmissions following hospitalisation cause distress for patients and families and are costly for healthcare systems. Reducing unplanned readmission rates is one of the key goals of healthcare systems, and reducing readmission rates was identified as one of the top strategic priorities by the World Health Organisation (WHO). (1)

Unplanned readmission is usually defined as a non-elective admission within one month of discharge from hospital. It may or may not be related to the previous visit, and not all unplanned readmissions are preventable. (2) In 2011, there were approximately 3.3 million readmissions (planned and unplanned) in the U.S., contributing $41.3 billion in total hospital costs. (3) Earlier statistics showed that approximately 90% of readmissions within 30 days of discharge appear to be unplanned and at least 80% relate to an acute medical complication. (4) There is a lack of published data on the extent and financial cost of unplanned readmissions in Australia.

A recent analysis of 30-day unplanned readmission rates in NSW public hospitals reported the overall rate as 6.8% between July 2009 and June 2012. (5) However, the rates for some medical conditions were much higher than others. Across NSW public hospitals, the 30-day rates of unplanned return to hospital for the five conditions examined ranged from 11% for ischaemic stroke to 23% for heart failure. (6) Notably, to date there are no published data for the ACT, or elsewhere in Australia, on which conditions have the highest 30-day unplanned readmission rates, nor which account for the highest burden of total readmissions. In addition, only a small number of studies have examined contributing factors for unplanned readmissions in Australia. These have shown

that age, comorbidity, indigenous Australians and people from low socioeconomic backgrounds are the most likely to be readmitted to hospital. (7-9)

The primary aim of this study was to examine which conditions have the highest rates of readmission and contribute most to 30-day unplanned readmissions in the ACT, and examine the extent to which key patient characteristics are associated with readmissions. Specifically, the objectives of this study are to:

1. Calculate the total number of 30-day unplanned readmissions over a one-year period (readmission burden), and the proportion of admissions with a 30-day unplanned readmission (readmission rate), among patients admitted to an ACT public hospital with selected conditions.
2. Calculate readmission burden and readmission rates separately by International Classification of Diseases 10th revision – Australian Modification (ICD-10-AM) chapter, condition and admission type (medical, surgical and other non-surgical procedural), and rank accordingly.
3. Quantify the association between age, sex, comorbidities and the risk of unplanned readmissions, separately by admission type.

3.4 Methods

3.4.1 Data source

The study used admitted patient data drawn from the public hospital ACT Admitted Patient Care (APC) Collection from July 2012 to June 2015. The APC is a complete census of all public and private hospital admissions in the ACT; however, only patients admitted to public hospitals could be internally linked to enable patients to be identified as the same individual, thus precluding the use of private hospital data for this study. The APC data collection comprised demographic and clinical information, including dates of admission and discharge, primary reason for admission and up to 99 additional clinical diagnoses coded using the ICD-10-AM. (10)

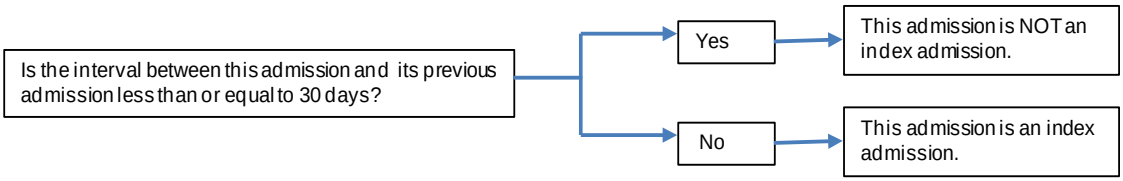
3.4.2 Study type and population

This was a prospective cohort study of 30-day unplanned re-admissions in ACT public hospitals between July 2012 and June 2015. Participants included all patients who had at least one admission at a Canberra public hospital — The Canberra Hospital or Calvary Public Hospital — during 1 July 2012 and 30 June 2015 (the study period). There was a total of 272,357 hospital admissions recorded in these two hospitals over the study period. An admission episode starts with admission and ends with leaving acute care, after taking into account transfers between hospitals/wards. The discharge date of that episode is the discharge date from the last hospital in the episode.

To determine 30-day readmissions, we first identified index admissions. An index admission was any admission during the study period that was more than 30 days after the discharge date of the previous admission for that patient. Figure 1 illustrates how we identified whether the admission was an index admission.

Figure 1. Identifying index admission – count backwards 30 days

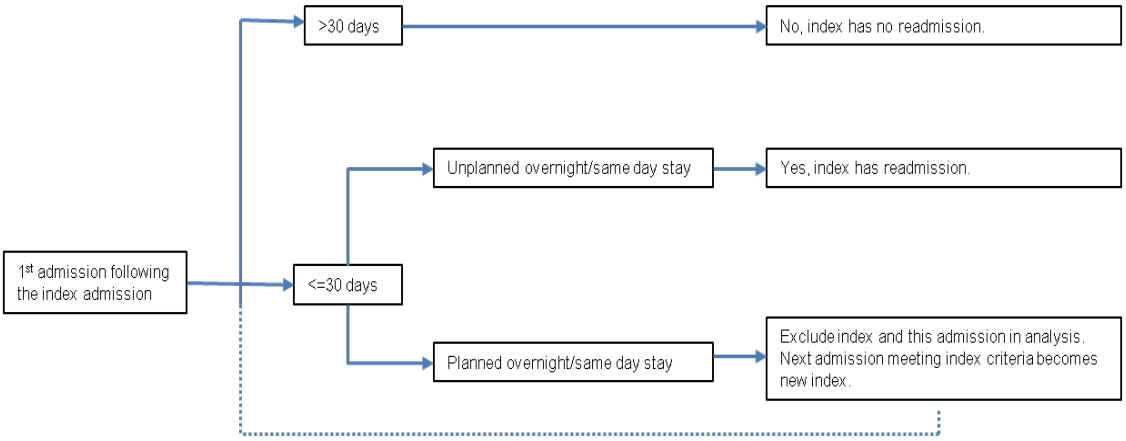
Question: Is this an index admission?



Patients were followed for 30 days from the date of discharge from each index admission. A 30-day unplanned readmission was defined as an unplanned return (urgency of admission was categorised as emergency, not elective) to acute care within 30 days of discharge of the index admission for any cause, regardless of whether or not the index admission was planned or unplanned. If the first admission following the index admission was over 30 days after discharge from the index admission, the index admission was identified having no readmission. If the admission after the index admission was within or equal to 30 days and was an unplanned stay, the index admission was identified as having an unplanned readmission. If the readmission was a planned stay, the

index admission and this admission were excluded in the analysis and the next admission meeting the index criteria became a new index admission. Figure 2 illustrates how we identified whether the index admission had a 30-day unplanned readmission.

Figure 2. Identifying readmission – count forward up to 30 days from index
Question: does the index admission have a 30-day unplanned readmission?



The study also excluded index admissions without at least 30 days of follow-up time. This included admissions where the patient died before being discharged from hospital or was discharged from the index admission after 31 May 2015.

Finally, we excluded index admissions that were related to cancer, maternal, and dialysis, as most of these conditions were likely to be planned admissions, even if within 30 days of a previous admission. These conditions were based on the ICD-10-AM for the primary reason for admission. These include all index admissions with codes in the following ICD-10-AM chapters: *Chapter 2 – Neoplasms; Chapter 15 - Pregnancy, childbirth and the puerperium; Chapter16 - Certain conditions originating in the perinatal period; Chapter 17 - Congenital malformations, deformations and chromosomal abnormalities; Chapter 18 - Symptoms, signs not abnormal clinical and laboratory findings, not elsewhere classified; Chapter 21 - Factors influencing health status and contact with health services.*

3.4.3 Analyses

Descriptive

We calculated readmission rates for each condition based on 3-character ICD-10-AM principal diagnoses codes, which were then grouped into: (1) ICD-10-AM chapters and (2) Clinical Classification Software (CCS) subgroups. The CCS is a tool for clustering patient diagnoses and procedures into a manageable number of categories without having to sort through thousands of codes. CCS aggregates individual ICD-10 codes into broad diagnosis groups by classifying diagnoses into 259 mutually exclusive and clinically meaningful diagnostic groups. (11) This grouping method has been used to identify cases for disease-specific studies, gain a better understanding of the distribution of certain conditions across disease groupings and examine trends in mortality by broad diagnosis groupings. (11) For reporting purposes, conditions having at least 100 index admission episodes were ranked within each admission type subgroup — medical, surgical or other non-surgical procedural, according to the second and third characters in the Australian Refined Diagnosis Related Groups (AR-DRGs) system (x01x – x39x: surgical DRGs; x40x – x59x: other non-surgical procedural DRGs; x60x – x99x: medical DRGs). (12) Results were reported by ICD-10-AM chapters and top 10 CCS subgroups within each admission type. Descriptive results were presented as total numbers of readmissions and readmission rates (percentage of index hospital admissions with readmissions).

Analytical

Within each medical, surgical and other non-surgical procedure admission type, we used logistic regression to quantify the strength of association between the risk of unplanned admission and patient characteristics based on index admission data: *age group* (categorised as 0-44, 45-64, 65-79, ≥80); *sex* (male, female); *and comorbidity* using the Charlson Index. This index is the sum of death propensity scores assigned to 16 conditions including pulmonary disease, diabetes, myocardial infarction, peripheral vascular disease, cerebral vascular disease, cancer and liver disease (13) (categorised as no comorbidity: total score of 0; mild-moderate comorbidity: total score of 1 or 2; or severe co-

morbidity: total score ≥2). Odds ratios, 95% confidence intervals (95%CI) and p-values are reported, with statistical significance being defined as $p<0.05$.

3.5 Results

The study sample comprised 81,839 patients who had a total of 142,330 acute care admissions between July 2012 and June 2015 (mean admissions per person =1.7, SD =2.55). Just under half (47%) of the study population was aged below 45 years, and 11% of the total study population were aged 80 years or older, and 52% were male.

The overall 30-day unplanned readmission rate (across all included conditions) was 6.2% (6,577/105,479). Ranking readmission rates by ICD-10-AM chapter, *diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism* had the highest 30-day unplanned readmission rate (10.1%), followed by *mental and behavioural disorders* (8.7%) and *diseases of the respiratory system (8.0%)*. However, these three chapters only contributed 16% (16,862/105,479) of the total burden of readmissions in our sample. The top 3 chapters in relation to number of readmissions were, in order, *Diseases of the digestive system (1,074), Injury, poisoning and certain other consequences of external causes (1,068), and Diseases of the circulatory system (993)*. (Table 1)

Table 1. Number of index admissions, readmissions and 30-day unplanned readmission rates by ICD-10-AM chapters in ACT public hospitals, July 2012 - June 2015, ranked by readmission rate

ICD-10-AM chapters for index admission	Number of index admissions	Total number of readmissions	Readmission rate (per 100 admissions)
Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism	1,567	158	10.1
Mental and behavioural disorders	5,042	440	8.7
Diseases of the respiratory system	10,253	818	8.0
Diseases of the circulatory system	12,715	993	7.8

Endocrine, nutritional and metabolic diseases	2,456	176	7.2
Certain infectious and parasitic diseases	4,186	285	6.8
Diseases of the genitourinary system	9,696	646	6.7
Diseases of the nervous system	3,922	240	6.1
Diseases of the digestive system	18,190	1074	5.9
Diseases of the skin and subcutaneous tissue	3,611	207	5.7
Injury, poisoning and certain other consequences of external causes	20,749	1068	5.1
Diseases of the musculoskeletal system and connective tissue	7,277	354	4.9
Diseases of the ear and mastoid process	1,254	31	2.5
Diseases of the eye and adnexa	4,561	87	1.9
Total	**105,479**	**6577**	**6.2**

Among medical admissions, the overall readmission rate was 7.8% (4,888/63,005) across all included conditions. Broken down by CCS subgroup (for index admissions with ≥ 100 episodes), *liver disease, alcohol-related* had the highest 30-day unplanned readmission rate *(19.2%)*, followed by *chronic obstructive pulmonary disease (16.1%)* and *congestive heart failure, non-hypertensive (15.3%)*. The top ten conditions with the highest 30-day unplanned readmission rates contributed 658 readmissions, accounting for 14.2% on the total readmissions associated with medical index admissions. (Table 2)

Table 2. Medical index admissions: The ten CCS subgroups with the highest 30-day unplanned readmission rates in ACT public hospitals (for index admissions with ≥ 100 episodes), July 2012 - June 2015

CCS subgroup	Number of index admissions	Total number of readmissions	Readmission rate (per 100 admissions)
Liver disease, alcohol-related	146	28	19.2
Chronic obstructive pulmonary disease	1,341	216	16.1
Congestive heart failure, non-hypertensive	877	134	15.3
Other lower respiratory disease	132	20	15.2
Biliary tract disease	648	98	15.1
Other liver diseases	128	19	14.8
Pleurisy, pneumothorax, pulmonary collapse	196	29	14.8
Chronic ulcer of skin	106	15	14.2
Complication of device, implant or graft	601	85	14.1
Immunity disorders	102	14	13.7
Total	**4,277**	**658**	**15.4**

Among surgical admissions, the overall readmission rate was 3.9% (1,330/34,116) across all included conditions. Broken down by CCS subgroup (for index admissions with ≥ 100 episodes), *heart valve disorders* had the highest 30-day unplanned readmission rate *(17.4%)*, followed by *other gastrointestinal disorders (11.9%)* and *other diseases of kidney and ureters and Aortic, peripheral, and visceral artery aneurysms (both 11.5%)*. The top ten conditions with the highest 30-day unplanned readmission rates contributed 201 readmissions, accounting for 18.2% in total readmissions associated with surgical index admissions. (Table 3)

Table 3. Surgical index admissions: The ten CCS subgroups with the highest 30-day unplanned readmission rates in ACT public hospitals (for index admissions with ≥ 100 episodes), July 2012 - June 2015

CCS subgroup	Number of index admissions	Total number of readmissions	Readmission rate (per 100 admissions)
Heart valve disorders	132	23	17.4
Other gastrointestinal disorders	101	12	11.9
Other diseases of kidney and ureters	208	24	11.5
Aortic, peripheral, and visceral artery aneurysms	192	22	11.5
Intestinal obstruction without hernia	225	23	10.2
Hyperplasia of prostate	141	14	9.9
Acute cerebrovascular disease	129	11	8.5
Calculus of urinary tract	341	27	7.9
Complications of surgical procedures or medical care	370	29	7.8
Cardiac dysrhythmias	206	16	7.8
Total	**2,045**	**201**	**9.8**

For other non-surgical procedure admission type, the overall readmission rate was 4.3% (360/8,359) across all included conditions. Broken down by CCS subgroup (for index admissions with ≥ 100 episodes), *biliary tract disease* had the highest 30-day unplanned readmission rate *(10.2%)*, followed by *acute myocardial infarction (8.4%)* and *other disorders of stomach and duodenum (8.2%)*. The top ten conditions with the highest 30-day unplanned readmission rates contributed 215 readmissions, accounting for 79.6% in the total readmissions associated with other non-surgical index admissions. (Table 4)

Table 4. Other non-surgical procedural index admissions: The ten CCS subgroups with the highest 30-day unplanned readmission rates in ACT public hospitals (for index admissions with ≥ 100 episodes), July 2012 - June 2015

CCS subgroup	Number of index admissions	Total number of readmissions	Readmission rate (per 100 admissions)
Biliary tract disease	488	50	10.2
Acute myocardial infarction	251	21	8.4
Other disorders of stomach and duodenum	110	9	8.2
Heart valve disorders	132	10	7.6
Pneumonia (except that caused by tuberculosis or STDs	125	9	7.2
Gastrointestinal haemorrhage	608	41	6.7
Chronic obstructive pulmonary disease and bronchiectasis	119	7	5.9
Regional enteritis and ulcerative colitis	215	11	5.1
Coronary atherosclerosis and other heart disease	1,040	46	4.4
Gastritis and duodenitis	256	11	4.3
Total	**3,344**	215	**6.4**

Logistic regression analyses showed that age and comorbidity, but not sex, were strong predictors for 30-day unplanned readmissions. Regardless of the index admission type (medical, surgical or other non-surgical procedure), rates increased significantly with increasing age and severity of comorbidities. The readmission rates among patients who had severe comorbidities were greater than 10%, within medical, surgical and other non-surgical procedure admission categories. For medical index admissions, patients aged 80 years or older (aOR=1.72; 95% CI = 1.58-87, compared to 0-44 years), or having mild-moderate (aOR=1.57; 95% CI = 1.46-1.69) or severe comorbidity (aOR=1.71; 95% CI = 1.51-1.94) versus none had an increased risk of being readmitted.

(Table 5) For surgical index admissions, patients aged 80 years or older (aOR=1.51; 95% CI = 1.26-1.82) or having mild-moderate (aOR=2.38; 95% CI = 2.06-2.75) or severe (aOR=3.51; 95% CI = 2.69-4.59) comorbidity had an increased the likelihood of being readmitted. (Table 6) For other non-surgical procedure admissions, patients aged 65-79 years (aOR=1.91; 95% CI = 1.41-2.59), or 80 years or older (aOR=1.73; 95% CI = 1.16-2.59) or having mild-moderate (aOR=2.37; 95% CI = 1.84-3.06) or severe (aOR=3.62; 95% CI = 2.25-5.83) comorbidity had an increased risk of being readmitted. (Table 7)

Table 5. Logistic regression to assess the association between age, sex, and comorbidities with the risk of 30-day unplanned readmissions, medical index admissions, July 2012 – June 2015

Patient characteristics	**Index admissions with unplanned readmissions**		**Index admission without unplanned readmissions**		**aOR**	**95%CI**	**p-value**
	N	**%**	**N**	**%**			
Age (years, at index admission)							
0-44	1,656	5.8	26,703	94.2	1.00	-	-
45-64	1,023	7.3	12,913	92.7	1.20	1.11-1.31	
65-79	1,118	10.1	9,982	89.9	1.56	1.44-1.70	<0.001
>=80	1,091	11.4	8,519	88.7	1.72	1.58-1.87	
Sex							
Male	2,358	7.6	28,770	92.4	1.00	-	-
Female	2,530	7.9	29,347	92.1	1.04	0.98-1.10	0.24
Comorbidity (Charlson Index)							
None	3,367	6.7	47,003	93.3	1.00	-	-
Mild-moderate	1,187	11.7	8,964	88.3	1.57	1.46-1.69	<0.001
Severe	334	13.4	2,150	86.6	1.71	1.51-1.94	

Table 6. Logistic regression to assess the association between age, sex, and comorbidities with the risk of 30-day unplanned readmissions, surgical index admissions, July 2012 – June 2015

Patient characteristics	Index admissions with unplanned readmissions		Index admission without unplanned readmissions		aOR	95%CI	p-value
	N	%	N	%			
Age (years, at index admission)							
0-44	412	3.0	13,398	97.0	1.00	-	-
45-64	358	4.0	8,666	96.0	1.16	0.99-1.34	
65-79	365	4.6	7,629	95.4	1.24	1.06-1.44	<0.001
>=80	195	5.9	3,093	94.1	1.51	1.26-1.82	
Sex							
Male	722	4.0	17,281	96.0	1.00	-	-
Female	608	3.8	15,504	96.2	0.98	0.89-1.10	0.75
Comorbidity (Charlson Index)							
None	980	3.3	29,095	96.7	1.00	-	-
Mild-moderate	282	8.1	3,185	91.9	2.38	2.06-2.75	<0.001
Severe	68	11.8	506	88.2	3.51	2.69-4.59	

Table 7. Logistic regression to assess the association between age, sex, and comorbidities with the risk of 30-day unplanned readmissions, other non-surgical procedural index admission, July 2012 – June 2015

Patient characteristics	Index admissions with unplanned readmissions		Index admission without unplanned readmissions		aOR	95%CI	p-value
	N	%	N	%			
Age (years, at index admission)							
0-44	70	2.5	2,701	97.5	1.00	-	-
45-64	113	4.5	2,403	95.5	1.59	1.17-2.16	
65-79	133	5.7	2,186	94.3	1.91	1.41-2.59	<0.001
>=80	44	5.8	709	94.2	1.73	1.16-2.59	
Sex							
male	198	4.4	4,294	95.6	1.00	-	-
female	162	4.2	3,705	95.8	1.03	0.83-1.27	0.81
Comorbidity (Charlson index)							
none	244	3.4	6,875	96.6	1.00	-	-
mild-moderate	94	8.7	981	91.3	2.37	1.84-3.06	<0.001
severe	22	13.3	143	86.7	3.62	2.25-5.83	

3.6 Discussion

This is the first study to calculate and rank, by condition, 30-day unplanned readmissions in the ACT, and to our knowledge, Australia. We identified an overall 30-day unplanned readmissions rate of 6.2% across all included conditions, 7.8% among medical admissions, 3.9% among surgical admissions and 4.3% non-surgical procedure admissions. For some conditions the unplanned readmission rates were relatively high, including for *liver disease, alcohol-related; chronic obstructive pulmonary disease; congestive heart failure; non-hypertensive heart valve disorders; and other gastrointestinal disorders.*

Our analysis showed strong associations between age, comorbidities and risk of unplanned readmission regardless of the admission type.

The overall rate of 30-day unplanned readmission observed in this study was generally low (6.2%) in comparison with published results for other countries: 5-29% in the U.S. (14), 16.7% in Hong Kong (15), and 15.3% in the United Kingdom (16). However, conditions with relatively high disease burden and/or readmission rates reported in other studies were also high in our study. For example, the NSW 30-day unplanned readmission rate for *congestive heart failure* was 23% (15.3% in our study). (6) *Chronic obstructive pulmonary disease* was reported to have a 30-day readmission (planned and unplanned) rate of 22.6% in the U.S (16.1% in our study). (4) However, *pneumonia* was normally reported to have a high readmission rate in other studies (4, 6, 15), but did not make to our top ten ranking. It is not clear as to why this was the case. Instead, we found some conditions had unexpected high readmission rates, including *biliary tract disease*, *chronic ulcer of skin* and *other lower respiratory disease*.

Regarding patient characteristics, those patients with underlying comorbidities were shown to be at increased risk of unplanned readmissions has been reported previously. (17-21) However, our findings on the associations between age and sex and risk of unplanned readmission are supported by some studies (20, 22), but not others (23, 24).

A number of factors might explain the disparities between the readmission rates observed between our study and others. Variations in methods and definitions, study criteria, and population groups are likely to be among the leading contributors. Variations in reporting results at different level, using ICD-10-AM coding or chapters, CCS subgroups, or admission type, also make it difficult to make direct comparisons between our findings and others. However, differences in readmission rates are also likely to reflect differences in characteristics of the local health care system that underlie readmissions, such as quality of in-hospital care, availability of hospital beds, access to primary

care, integration of inpatient and outpatient care; and availability of community and social support services.

This study is novel in that it provides insight into all-cause unplanned readmission rates, instead of restricting the analysis to a limited number of specific diseases. The ranking provides evidence to identify and understand conditions responsible for high readmission rates and burden in public hospitals in the ACT. Notably, conditions with high readmission rates do not necessarily lead to the highest burden of unplanned readmissions. For example, *Liver disease, alcohol-related* had a high readmission rate, 19.2%, but only had 28 readmissions over the study period. Limitations of this study include that we only had data for admissions to public hospitals and it was impossible to identify those patients who may have readmitted to private hospitals after being discharged from public hospitals. Therefore, the readmission rates for publically admitted patients observed in our study are likely to be under estimated (however this is not likely to be large), and results are not necessarily generalisable to private hospital admissions. Furthermore, administrative data allow only limited examination of reasons underlying readmissions.

As a wide range of factors can affect the unplanned readmission rates, these rates are most usefully applied as screening tools. Conditions with high readmission rates or burden identified in this study should be targeted for further investigation to examine what specific factors are associated with the readmission risks. Moreover, the rankings created in this study can guide efficient cost utilisation and resource management in the health care system. Although readmission rate is often presented as a hospital performance measure, the study findings reinforce the importance of considering patient factors, especially age and comorbidities, in the interpretation. Without adequately being taken into account, patient factors can adversely affect the outcome as one U.S. study found that higher quality hospitals serving vulnerable or medical complex patients were unfairly penalised for apparently poor performance. (25) Our findings also suggest it would be useful to consider the needs for elderly patients and those with underlying comorbidities in the

preventing strategies and post-discharge plans to reduce unplanned readmissions. Further analyses of these data, incorporating risk adjustment for age and comorbidity, would also be useful. This would provide complementary evidence on the potential “preventability” of readmissions to guide which areas health systems could focus on to reduce readmission rates.

A variety of interventions to reduce readmissions have been assessed by other studies. (26-29) Interventions targeting specific patient population were found to be more effective than generalised populations. (30, 31) Discharge services including follow-up phone calls and arranged appointments, medication reconciliation, patient education and communication to the primary care providers can possibly reduce 30-day readmission risk. (32, 33) Other post-discharge interventions found effective include targeting nutritional and mood status, intense self-management, and transition coaching and nurse home visits. (21, 30) However, because of the resource-intensive nature, the efficiencies of these approaches depends on being able to identify and target high-risk patients; but prospectively identifying patients at elevated risk of readmission has been challenging. (34)

3.7 Conclusion

Our findings provide a comprehensive ranking for all cause 30-day unplanned readmission rates in ACT public hospitals. For some conditions the rates were relatively high, suggesting areas to target for reducing readmissions. Older age and comorbidities are strong predictors for 30-day unplanned readmissions. Therefore, when developing preventative strategies and post-discharge plans, particular consideration should be given to patients at older age or with underlying comorbidities. The findings also reinforce the importance of identifying patients and conditions that have high unplanned readmissions to guide efficient resource utilisation, and to support the cost of interventions to those likely to benefit most.

3.8 References

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CHAPTER 4 - Evaluation of the ACT General Health Survey to monitor overweight, obesity, nutrition and physical activity in ACT adults and children

4.1 Prologue

4.1.1 Study rationale

There are three aspects of the rationale to evaluate the ACT General Health Survey (GHS). Firstly, the survey has not been evaluated since it was introduced in 2007. Secondly, the Epidemiology Section identified the need to undertake a formal review of the ACT Health Survey Program (HSP). Lastly, the survey provides data for health promotion programs in regards to nutrition and physical activity indicators, including the 'Healthy Weight Action Plan' (HWAP). The plan was initiated in 2013 to maintain the prevalence of overweight and obesity at or below their current level – the goal of 'zero growth' in the ACT. (1) So when the plan was due for evaluation, the need to evaluate the GHS was raised.

4.1.2 My role

My supervisors helped develop the concept and I designed this project. After reviewing the methods in the literature on how to evaluate a population health survey, I identified two key documents that describe activities and steps to evaluate a health surveillance system. I undertook literature review, data analysis, stakeholder consultation to assess the performance of the survey. For example, for stakeholder consultation, I identified potential candidates, designed the questionnaire, prepared an information sheet, scheduled appointments and conducted face-to-face interviews. I also participated in evaluation workshops that were run by external consultants and project staff from NSW Health, together with my colleagues in the survey team. These workshops were great opportunities to learn how to manage and conduct population health surveys, which also provided valuable information and insight into the ACT HSP.

4.1.3 Lessons learnt

During the process of evaluating the GHS, I learnt valuable lessons that can be applied not only in survey evaluation, but also throughout project management

and evaluation. I found communication and organisation skills were essential in seeking information from stakeholders. I learnt how important it was to understand people's roles in the system to ensure right questions were asked to the right person. At the start of the consultation, I had a list of same questions for all stakeholders. But after a couple interviews, I realised it was necessary to customise the questions to tailor to different people as not everyone was familiar with all parts of the survey. I found if questions were more relevant to their roles, people were more likely to provide constructive information. Before launching the formal stakeholder consultation, it was also helpful to run a trial interview with someone who understood the survey well and was able to provide feedbacks.

Another important lesson I learnt was the importance of 'doing the homework' and providing background information to stakeholders. One of the challenges I encountered was how to actively engage key informants in the evaluation. In the early stage of the project, I had a blunt 'Q and A' approach to ask for input, which did not achieve expected outcomes. However, when I prepared an information sheet, which outlined a survey introduction, purpose of the evaluation and the questions I was interested in, it was more successful in obtaining information. I also explained how the evaluation could possibly benefit people's roles in the survey to minimise their concerns and misunderstandings.

4.1.4 Public Health Implications

This evaluation complemented the review of the ACT HSP to monitor population health in the ACT. By documenting the operation of the system, examining information needs, and identifying data gap and alternative sources, the project provides information that could be used to enhance the efficiency and effectiveness of the system. It highlights the role of this system as a surveillance tool to monitor changes of overweight and obesity for the ACT population.

4.1.5 Acknowledgements

I wish to acknowledge the following persons and organisations of their assistance with the evaluation: Oscar Yang, Bridget O'Connor, Lindy Fritsche, Deb Schaler and Paul Kelly at ACT Health; Rosemary Korda at the National

Centre of Epidemiology and Population Health, ANU; Margo Barr at Sax Institute; Tim Harrold and Suzanne Schindeler at NSW Ministry and Mel Thompson at the Youth and Family Support in ACT Community Services.

4.2 Abstract

Overweight and obesity has become one of the leading health concerns in Australia including ACT. The purposes of this evaluation were to document the operation of the ACT General Health Survey (GHS) and assess its performance as a surveillance system to monitor overweight, obesity, nutrition, and physical activity for adults and children.

Activities and steps outlined by two documents, *Updated Guidelines for Evaluating Public Health Surveillance Systems* and *Evaluating an NCD-Related Surveillance System (Participant Workbook)* were used in evaluating the GHS. Information was collected through workshops, literature review, data analysis, stakeholder consultation and key informant interviews.

As part of the ACT Health Survey Program (HSP), the GHS is a computer-assisted telephone interviewing survey conducted every year in ACT. The annual sample of the survey was around 1700 among ACT residents. The data collected are used for various purposes, including describing and monitoring the frequency and distribution of overweight, obesity, physical activity and nutrition among adults and children over time; and creating awareness of overweight, obesity and unhealthy physical and dietary behaviours. Survey questions are reviewed every year to meet stakeholders' needs, reporting requirements or guideline changes. There are some compatibility shared between the GHS data and other survey data.

The GHS is a useful surveillance tool to monitor trends of overweight, obesity, nutrition and physical activity for adults and children in the ACT. However, improvements could be made in a few areas, including: developing a proper evaluation plan and a data quality statement, increasing the sample size and the proportion of young people in the sample population.

4.3 Background

This section states the public health importance of overweight and obesity in terms of prevalence, inequalities, impact on health, costs and preventability.

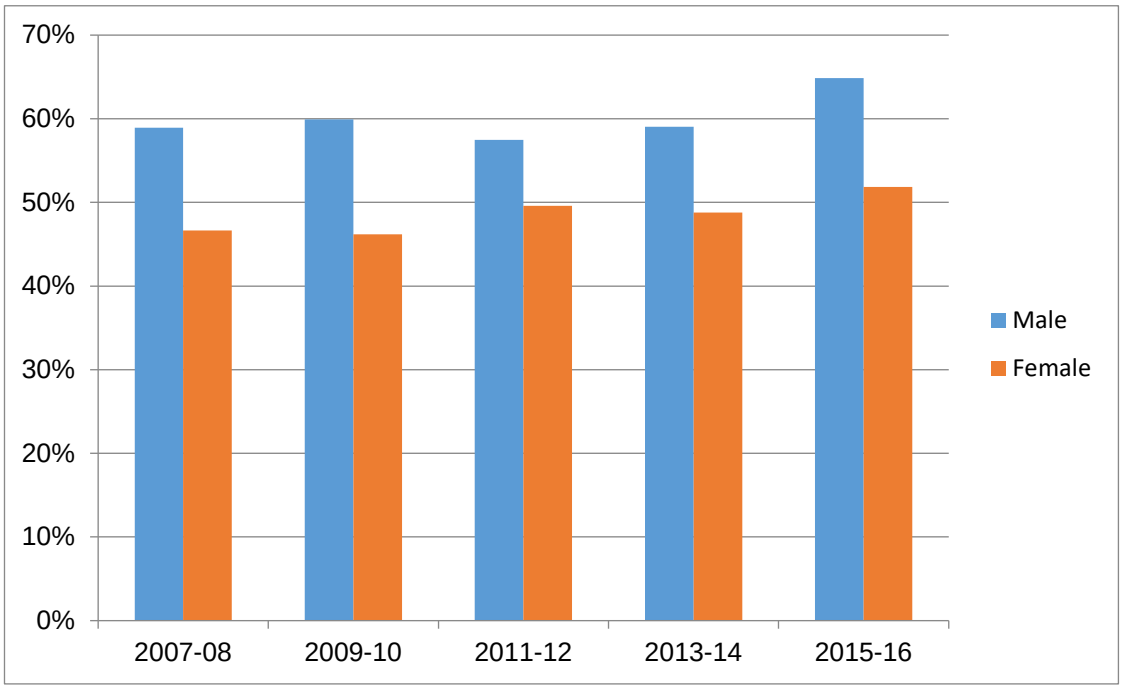
4.3.1 Public health importance of obesity and overweight

Overweight and obesity has become one of the leading health concerns in Australia. The prevalence of obesity among Australian adults is 28%, far above the Organisation for Economic Co-operation and Development countries average of 18%. (2) People from disadvantaged background are more likely to report overweight and obesity than others. (3) Overweight and obesity is an established risk factor for a number of chronic diseases and conditions. (3) Their associated social and economic costs can be substantial. (4) Evidence of preventing weight gain is mixed, with physical activity and good nutrition both effective.

Prevalence

In Australia, over half of the population is overweight or obese, with the prevalence higher in men than women. In 2014-2015, 63% of Australian adults were overweight (35%) or obese (28%). (5) The proportion of adults being overweight or obese was higher in Australian men (71%) than in women (56%); and highest among people aged 65-74 years (74%) and lowest in those aged 18-24 years (39%). (5) Similar to the national pattern, in the ACT, over half (58%) of the adult population were overweight or obese in 2015-16, with higher prevalence in men (65%) than women (52%). (6) (Chart 1)

Chart 1. Proportion of overweight and obesity in adults by year and sex, ACT 2007-2016.



Source: ACT General Health Survey, 2007-2016

Inequalities

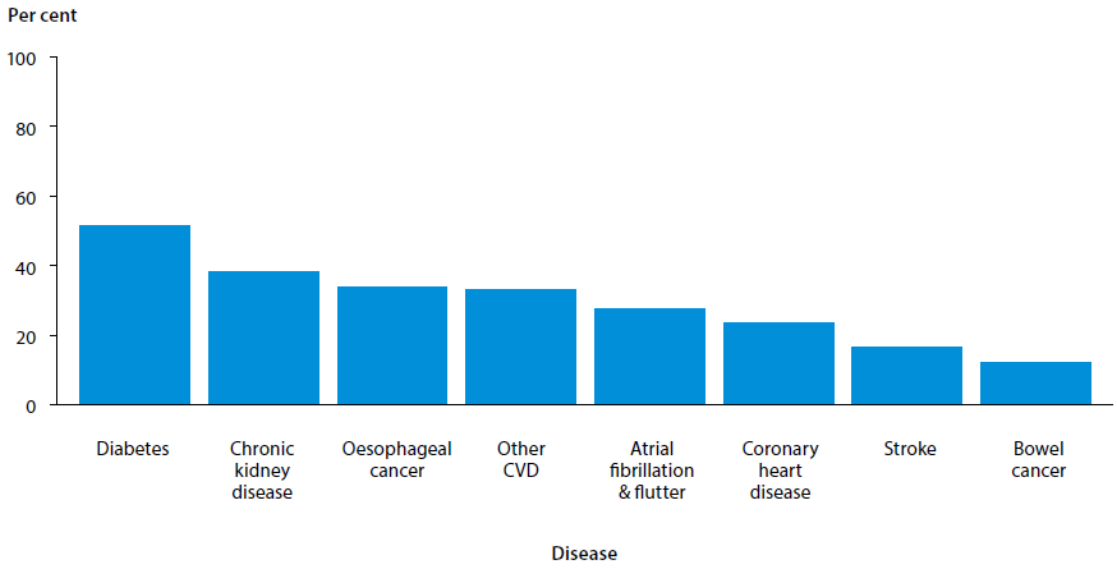
In Australia, some sub-population groups have higher prevalence of overweight and obesity than others. In 2014-15, more women living in areas of most disadvantage were overweight or obese (61.1%) than women living in areas of least disadvantage (47.8%).(7) People living in Regional and Remote Australia (69.2%) had higher rates of overweight and obesity compared with adults living in Major Cities (61.1%).(7) Indigenous people were significantly more likely than non-Indigenous people to be either overweight or obese (1.2 times as likely) and to be obese (1.6 times as likely) (8)

Impact on health

Overweight and obesity are known to be associated with numerous adverse health outcomes. Being overweight or obese increases risks of developing cardiovascular disease, type 2 diabetes and some cancers, along with mental health and eating disorders.(9) It is also associated with high blood pressure, dyslipidaemia and atherosclerosis.(9) High body mass contributed 5.5% of all disease and injury burden in 2011 in Australia, ranking as the risk factor with the

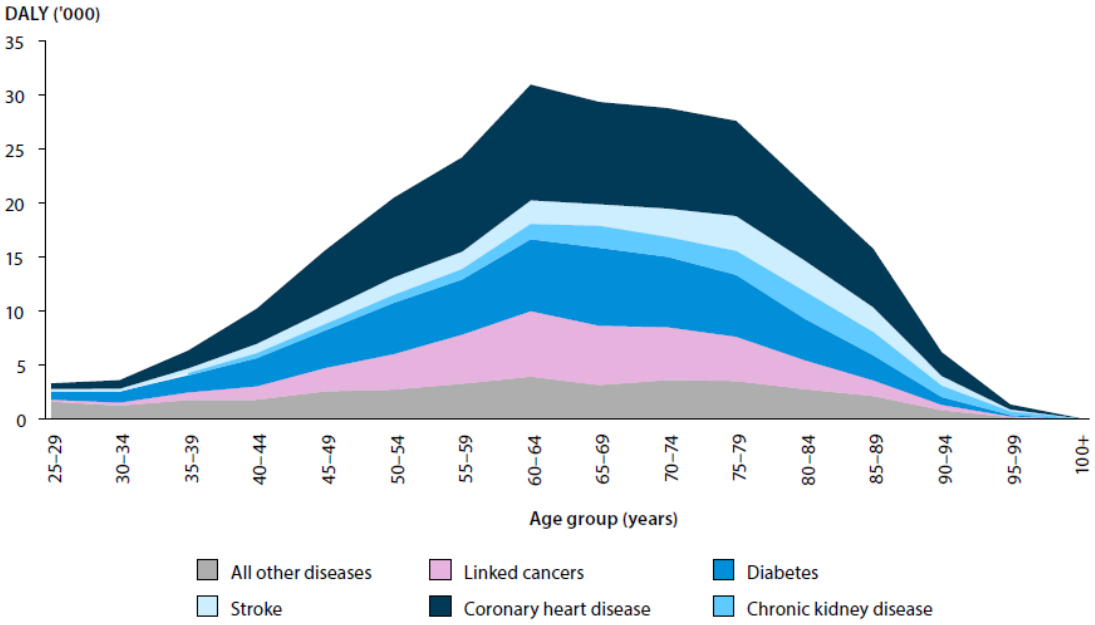
second highest attributable burden.(10) It was responsible for 52% of diabetes burden, 38% of chronic kidney disease burden, 23% of coronary heart disease burden and 17% of stroke burden. (10) (Chart 2) The top diseases attributable to high body mass showed a similar health loss contribution by age. (10) (Chart 3)

Chart 2. Burden (percentage of linked disease) attributable to high body mass, top eight diseases, 2011



Source: Australian Institute of Health and Welfare 2016. Australian Burden of Disease Study: Impact and causes of illness and death in Australia 2011. Australian Burden of Disease Study series no. 3. BOD 4. Canberra: AIHW.

Chart 3. Burden (DALY) attributable to high body mass by age and disease, 2011



Notes:
1. 'All other diseases' includes atrial fibrillation & flutter, back pain & problems, cardiomyopathy, hypertensive heart disease, inflammatory heart disease, osteoarthritis, other cardiovascular diseases and peripheral vascular disease.
2. 'Linked cancers' includes bowel cancer, breast cancer, gallbladder cancer, kidney cancer, oesophageal cancer, pancreatic cancer and uterine cancer.

Source: Australian Institute of Health and Welfare 2016. Australian Burden of Disease Study: Impact and causes of illness and death in Australia 2011. Australian Burden of Disease Study series no. 3. BOD 4. Canberra: AIHW.

Costs

The costs associated with overweight and obesity are substantial. It was estimated that in 2005 the direct and indirect cost associated with overweight and obesity, including government subsidies, loss of productivity and early retirement, resulted in an overall total annual cost of $56.6 billion in Australia. (4) The figure consisted of $21 billion direct cost ($6.5 billion on overweight and $14.5 billion on obesity) and $35.6 billion government subsidies ($12.8 billion on overweight and $22.8 billion on obesity).(4) Another study conducted in Australia found that the direct and indirect costs of obesity and obesity-related illnesses in 2008/09 were estimated to be $37.7 billion.(11) These included associated medical costs ($1.3 billion), productivity losses ($6.4 billion) and burden of disease ($30 billion).(11) It was difficult to compare these two studies

due to differences in methodology but both studies show substantial costs related to overweight and obesity.

Preventability

Many studies have investigated the determinants of overweight and obesity; despite this, controversy remains in identifying major drivers. A comprehensive assessment undertaken by the WHO examined a range of proximal and distal factors and identified that regular physical activity and high dietary fibre intake were effective in preventing weight gain; and high intake of energy-dense foods and sedentary lifestyles increased the risks. (12) (Table 1) Combination approaches are also found to be more effective than single interventions. (13)

Table 1. Summary of the strengths of evidence on factors that might promote or protect against weight gain and obesity

Evidence level	**Factors associated with decreasing the risk of overweight and obesity**	**Factors associated with increasing the risk of overweight and obesity**
Convincing	Regular physical activity; High dietary fibre intake;	High intake of energy-dense foods (high in fat/sugar); Sedentary lifestyles;
Probable	Home and school environment that support healthy food choices for children; Promoting growth;	Heavy marketing of energy dense foods and fast foods outlets; Adverse social and economic conditions in developed countries (especially for women); Sugar-sweetened soft drinks and juices;
Possible	Low glycaemic index foods; Breastfeeding;	Large portion sizes; High proportion of food prepared outside of homes; Rigid restraint/periodic disinhibition eating patterns;
Insufficient	Increased eating frequency;	Alcohol;

Source: Gill H, King L, Vita P et al. 2010. A "state of the knowledge' assessment of comprehensive interventions that address the drivers of obesity – a rapid assessment. The Boden Institute of Obesity, Nutrition, Exercise and Eating Disorders, University of Sydney. Camperdown, NSW.

4.4 Introduction

As part of the ACT HSP, the GHS is a computer-assisted telephone interviewing (CATI) survey conducted from November/December to the following April every year among ACT residents. It was developed to address issues around small ACT sample sizes in national surveys, irregularity of national surveys and inability to always meet information needs in a timely manner. (14) The survey collects information on various topics including health behaviours, health status, use of health services and other associated factors, including self-reported height and weight, nutrition and physical activity status among adults and children. The data collected are used to provide evidence to understand and analyse overweight and obesity patterns in the ACT and meet reporting requirements.

4.4.1 System aim and objectives

The GHS is one of the main instruments through which the ACT Health monitors population health and reports on performance indicators. Specific objectives of the survey as stated in the *ACT Population Health Bulletin* (15) include to:

- monitor changes over time in self-reported health behaviours, health status, health service use, satisfaction with health services, and other factors that influence health;
- support the planning, implementation, and evaluation of health services;
- collect health information that is not available from other sources;
- respond to emerging needs for health information;
- promote research; and
- provide a tool to measure the *National Partnership Agreement on Preventive Health* performance indicators.

4.4.2 Purpose of Evaluation

The purposes of this evaluation were to (1) document the operation of the system; and (2) assess its performance as a surveillance system to monitor overweight, obesity, nutrition, and physical activity. The evaluation intended to complement the formal review of the ACT HSP, as well as to fulfil the Master of Applied Epidemiology (MAE) requirements in evaluating a surveillance system.

4.5 Methods

There is limited literature on how to evaluate a population health survey. Principles and methods illustrated by two documents, *Updated Guidelines for Evaluating Public Health Surveillance Systems* and *Evaluating an NCD-Related Surveillance System (Participant Workbook),* developed by the Centers for Disease Control and Prevention (CDC) were used to evaluate the GHS in this project. The first document is the core report for the methods that describes tasks and activities involved in evaluating a public health surveillance system. It provides standards for each of the tasks to assess the quality of the evaluation activities, which are adapted from the standards for effective evaluation (i.e., utility, feasibility, propriety, and accuracy) in the *Framework for Program Evaluation in Public Health. (16)* However, given not all attributes under the evaluation framework were relevant to the GHS, only those appropriate were used in this project. The second document outlines the process of evaluating a non-communicable disease surveillance system. It is a self-learning training module that is based primarily on the updated CDC Guidelines for Evaluating Surveillance Systems and its earlier version in 1988, but focuses on non-communicable diseases.

By reviewing the above two documents, the following attributes were assessed in the evaluation: usefulness, simplicity, stability, acceptability, data quality, sensitivity/accuracy, representativeness, timeliness, and stability/coherence. Key questions, methods and analysis performed to assess each attribute were listed in Appendix 2. Information were collected through workshops, literature review, data analysis, stakeholder consultation and key informant interviews.

4.6 Results

4.6.1 System operation

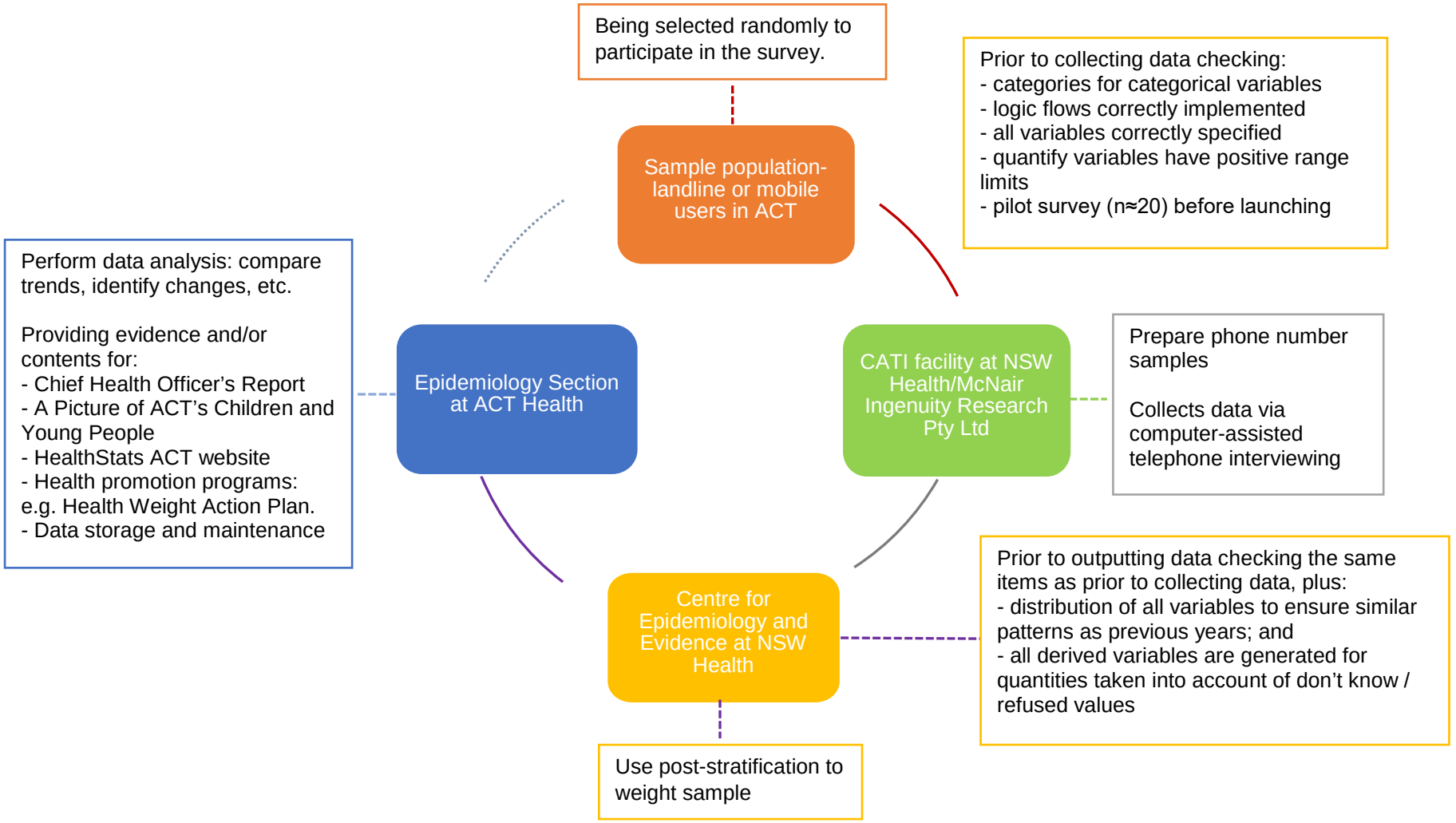
The Epidemiology Section at ACT Health owns and manages the GHS, develops the survey content, analyses the data and reports the findings. The data collection, collation and preliminary data cleaning/analysis including applying population weights are outsourced and undertaken by NSW Health. From 2007 to 2014, interviews were carried out in-house at the Health Survey

Program CATI facility at NSW Health. In 2015, McNair Ingenuity Research Pty Ltd (a market research agency) took over the administration role of conducting all NSW Population Health Surveys (NSWPHS) including the GHS. (Figure 1)

The GHS aims to capture an annual sample of around 1700 (1200 adults and 500 children) ACT residents. Sample population were randomly selected, the questionnaire was checked for logic flows and then a pilot survey was conducted. The GHS follows the standard CATI procedure that uses script and programmed questions in the interviews. Most of the questions on nutrition and physical acclivity are independent from each other so order of the questions being asked can be alternated. NSW Health performs data checking and sample weighting before outputting the dataset to ACT Health. Data collected by the survey can be presented in various formats, including SPSS, Excel and CVS as confidential, aggregated or unit record files. The Epidemiology Section at ACT health performs data analysis and uses the data for reports and policies. Data analysis is conducted using a range of analysis packages including SPSS, SAS and Stata.

Currently the sampling design for the GHS is random selection of households within the ACT. From 2012, the GHS changed from a landline random digit dialling (RDD) phone frame to an overlapping dual-frame using ACT mobile phone users identified during the recruiting process for the NSWPHS. The sample design for the landline frame was simple random sampling of clusters (household telephone numbers) and simple random sampling of population elements (household residents of any age) within each cluster; whereas in the mobile frame sample design, rather than having a household to select from, the mobile phone owner, if over 16 years, was selected. (14) Up to 7 call attempts are made to establish initial contact with a household or mobile phone owner, and up to 5 call attempts to secure an interview with the selected respondent. (17)

Figure 1. Flow Chart of Data Transmission, ACT General Health Survey



4.6.2 System performance

The performance of the GHS was assessed by describing the usefulness and attributes of the system in accordance with the CDC guidelines (CDC 2001 and CDC 2013).

Usefulness

The data collected by GHS are mainly used for the *Chief Health Officer's (CHO's) Report* and routine reporting. In the 2016 CHO Report, GHS data on height, weight, nutrition and physical activity were used to create or contribute contents for chapters of "Healthy Weight", "Healthy Lifestyle" and "Healthy people", which report on healthy weight, healthy eating and active living. *A Picture of ACT's Children and Young People* (Children's report) is an annual report developed by ACT Community Services that uses the GHS data to report on health, wellbeing, learning and development of children and young people, including fruit and vegetable consumption and participation in physical activity. (18) Through these reports, the GHS data are used to:

- describe and monitor the frequency and distribution of overweight, obesity, physical activity and nutrition among adults and children over time; and
- create awareness of overweight, obesity and unhealthy physical and dietary behaviours;

Other use of the GHS data include providing evidence to develop:

- overweight and obesity prevention policies and programs including:
    - *Ride or Walk to School* (Active Travel to School Program);
    - *Fresh Tastes: healthy food at school* program;
    - *Good Habits for Life* program;
    - *Healthy Weight Action Plan*;
- government web pages and documents including annual reports, factsheets, briefs and minutes
    - HealthStats ACT website.

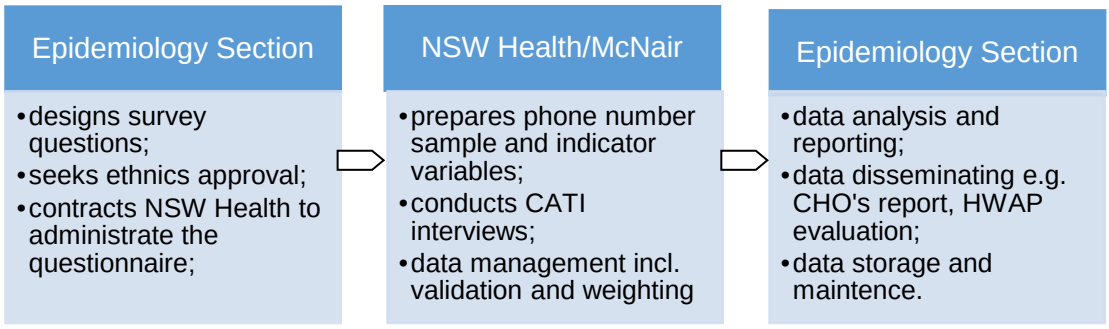
➢ Recommendations

There is no explicit evaluation of how the data has been used or dissemination plans in place. The development of such plans may help increase the survey impact and data use. For example, several stakeholders have suggested creating an open-access webpage for the GHS so that relevant survey information, including the data dictionary, tables of results and published reports can be provided for public use.

Simplicity

As discussed in the system operation, there are two major parties that are involved in operating the system. ACT Health designs, analyses and uses the data collected by the survey, while outsourcing the data collection, collation and preliminary data cleaning/analysis to NSW Health/McNair Research. (Figure 2) Outsourcing parts of the survey components is for cost benefits and maximising the use of established resources. Although this simplifies the process of collecting data in-house, ACT Health loses some control on data quality and adds another layer in management by liaising with another stakeholder. Trained and experienced personnel use a standard script with instructions to conduct the interviews, with supervision provided. (17)

Figure 2: Roles and relationships of ACT Health and NSW Health in the system.



Nutrition and physical activity questions are part of the ‘Health Behaviour’ module in the survey (numbers and measurements are listed in Appendix 3). It is difficult to compare these questions with the same component questions in other surveys as data are collected in different formats. Taking the nutrition questions for example, both the National Health Survey (NHS) and GHS use

indicators on type of milk consumed, daily intake of fruit and vegetables and use of salt, but they differ in collecting additional dietary information. NHS uses a food diary asking about all food and drink consumed in the 24 hours prior to interview, and food avoidance behaviours, while the GHS uses more specific indicators including how much fast food and sugary drinks consumed.

- Recommendations

The survey program is investigating the applicability and acceptability of collecting data online in the future to improve the simplicity of the system. Although this method is likely to be easier for regular computer users, it would be difficult for those who need help using a computer and accessing the Internet.

Stability

The GHS is stable but also flexible to respond to changes and meet different demands. As a surveillance system, its method of collecting data has updated since 2012 to incorporate mobile users into the sampling strategy. The reason for that was the growing use of mobile phones and concomitant reduction in landline use, with the literature highlighting important differences between people who are selected from a landline frame and a mobile frame. (14) Data collected on height, weight, nutrition and physical activity have been consistent from 2007 to 2016, except missing the component of children's physical activity in 2011. It was impossible to trace the reason for this missing component at the time of this study - it was not adequately documented and the discussion with the team was inconclusive.

In regards to the stability of the survey questions, they are reviewed every year to meet stakeholders' needs, reporting requirements or guideline changes. Some indicator variables changed over time due to changes in national guidelines (e.g. adequate fruit and vegetable intake, adequate physical activity). When this occurred, a new indicator variable was created so the trend would not be distorted. (14) Changes in definition or guideline that affect the

measurement would be reflected in the revised questions and recorded in the data dissemination report.

The Epidemiology Section is undertaking a formal review of the entire HSP. The review is examining the length, coverage, structure and frequency of all health surveys, as well as the importance and relevance of each question. The process is expected to have a significant impact on how the GHS operates and the flexibility it could have in the future.

Acceptability

Main data users include the Chief Health Officer and the Health Improvement Branch at ACT Health who expressed overall satisfactions on the system and its collected data.

In addition, the response rates, cooperation rates and refusal rates indicate how well the survey is being accepted. Definitions of these rates are provided below according to the American Association for Public Opinion Research (19):

> *Response rates: the number of complete interviews with reporting units divided by the number of eligible reporting units in the sample.*
> *Cooperation rates: the proportion of all cases interviewed of all eligible units ever contacted.*
> *Refusal rates: the proportion of all cases in which a housing unit or the respondent refuses to be interviewed, or breaks-off an interview, of all potentially eligible cases.*

From 2014 to 2015, GHS had an average 20% response rate, 42% cooperation rate and 46% refusal rate, compared to 31% response rate, 63.3% cooperation rate and 24.5% refusal rate of NSWPHS in 2012.

Data quality

The GHS questions are validated or have been used in other surveys. For example, the children's physical activity questions are adapted from the *Active Australia Survey*. Most of other nutrition and physical activity questions are

adapted from the NSWPHS, many of which are validated questions from other sources. The NSWPHS include *Adult Population Health Survey, School Students Health Behaviours Survey and Child Population Health Survey*. (20) National guidelines are used to structure and frame these questions. *The Australian Dietary Guidelines* are used to guide nutrition questions. The Australia's Physical Activity and Sedentary Behaviour Guidelines including *Australia's Physical Activity and Sedentary Behaviour Guidelines for Children (5-12 years)* and *Australia's Physical Activity and Sedentary Behaviour Guidelines for Adults (18-64 years)* are used for physical activity questions.

The sample is weighted to adjust for differences in the probabilities of selection. However, the standard ratio of 5:5 used in the weighting between landline and mobile users by NSW Health does not reflect the ACT sample ratio of 9:1. No formal data quality statement is provided but it is estimated that the average missing values per question is less than 10%. For example, only 0.9% average missing values for height and 2.9% for weight, 1.5% for fruit consumption and 0.6% for vegetable consumption for adults. There is a noticeable increasing trend of missing values for weight from 2007 to 2016.

- Recommendations

Biostatical expertise has suggested investigating and applying an appropriate weight formula to reflect the true distribution between landline and mobile users in the ACT sample. Feedbacks from the workshop also include developing a data quality statement using a standard format such as the ones from the Australian Bureau of Statistics (ABS) and Australian Institute of Health and Welfare (AIHW).

Sensitivity/accuracy

Self-report measures of height, weight, nutrition and physical activity are collected by the GHS. The validity of using self-reported data to estimate BMI and assess nutrition intake and physical activity has been widely discussed. Individuals tend to overestimate their height and underestimate their weight (21, 22), but previous studies have demonstrated that self-reported height and

weight correlate well with measured values. (21-26) However, it is found that shorter individuals are more likely than taller individuals to overestimate their height, and women are likely to under report their weight to a greater extent than men.(21-23) The validation study of the 2007-08 NHS found mean differences in self-reported and measured information of +0.97cm in males and +0.75cm in females for height, and of -1.08kg in males and -1.41kg in females. (27) When this mean difference is applied to the 2014-2015 GHS data, mean BMI in males shifted from 27.0 to 27.5; and 26.3 to 27.1 in females, but remained in the same category of being 'overweight'. Therefore, although overweight and obesity rates using self-reported data are likely to be underestimated for relative measures, comparisons across population groups and changes over time in the BMI categories have been captured well using the GHS data.

In regards to using self-reported measures to assess physical activity, a systematic review found that the measurement method may have a significant impact on the observed levels of physical activity. (28) Self-report measures of physical activity were both higher and lower than directly measured levels of physical activity, which poses a problem for both reliance on self-report measures and for attempts to correct for self-report and direct measure differences.(28) Another study found that self-reported energy intake and food frequency questionnaire were significantly lower than objectively measured total energy expenditure. (29) Therefore, using self-reported measures are likely to underestimate the dietary intake in reality.

- Recommendations

Despite the evidence that validation studies provide the most direct method for adjusting self-reported measures, this is not necessarily recommended. Validation studies are relatively expensive to conduct (requiring measurements of weight and height be taken), and there are a large numbers such studies already published. (21-22, 28) Therefore, a feasible way forward would be to apply appropriate correction equations from these published studies to the ACT data.

Representativeness

The annual sample was around 1700 (1200 adults and 500 children) among ACT residents. However, only 10% of the sample was recruited from the mobile frame due to difficulty identifying ACT mobile phone users as no geography was associated with the mobile phone numbers in Australia. (14) For example in 2015, 1,030 adults were recruited from the landline frame and 179 were recruited from the mobile frame. Consequently, the sample was over represented by elderly people and under represented by people aged between 20-44 years, when comparing the GHS sample with the ABS 2014 mid-year population estimates. (Chart 4) A comparison of the age distribution between the ACT population and the GHS sample population also showed the survey is poorly representing the true distribution. (Chart 5, Chart 6) Many of the fields of the social-demographic information were optional and incomplete, which made it difficult to identify specific sub populations that are over/under represented in the sample.

Chart 4. Age distribution of the ACT General Health Survey (GHS) sample and Australian Bureau Statistics (ABS) estimates

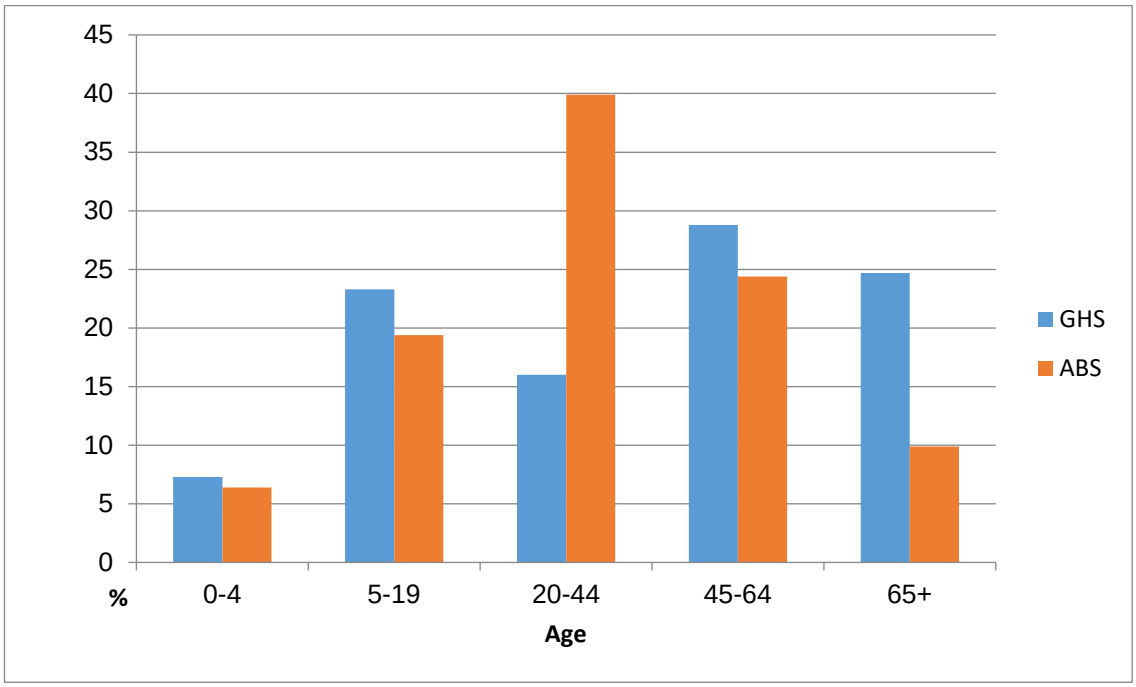
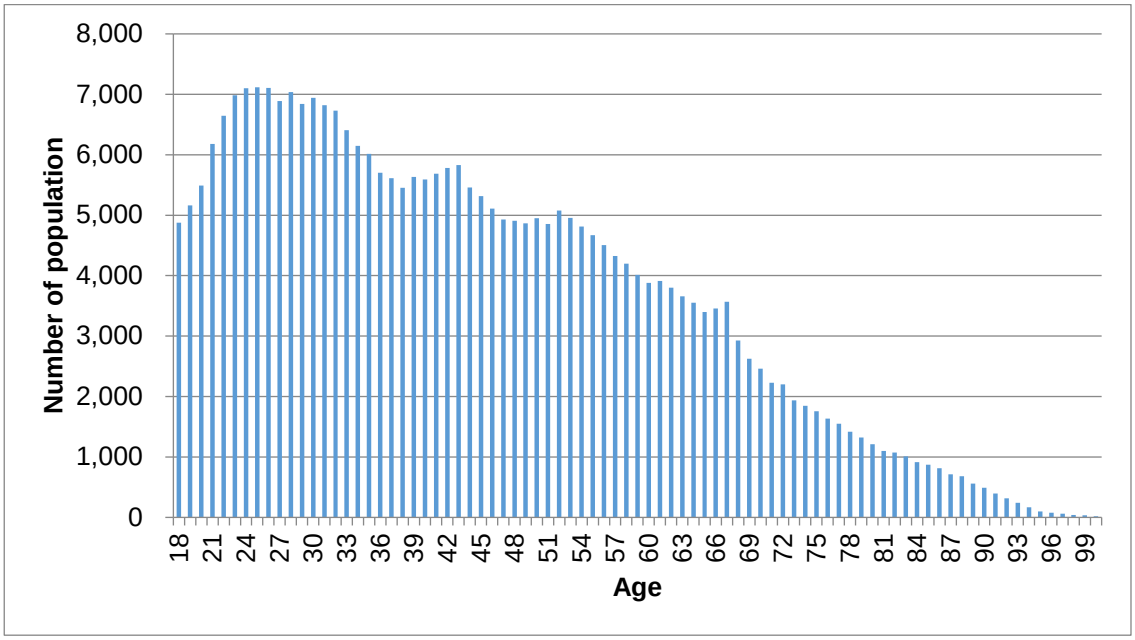
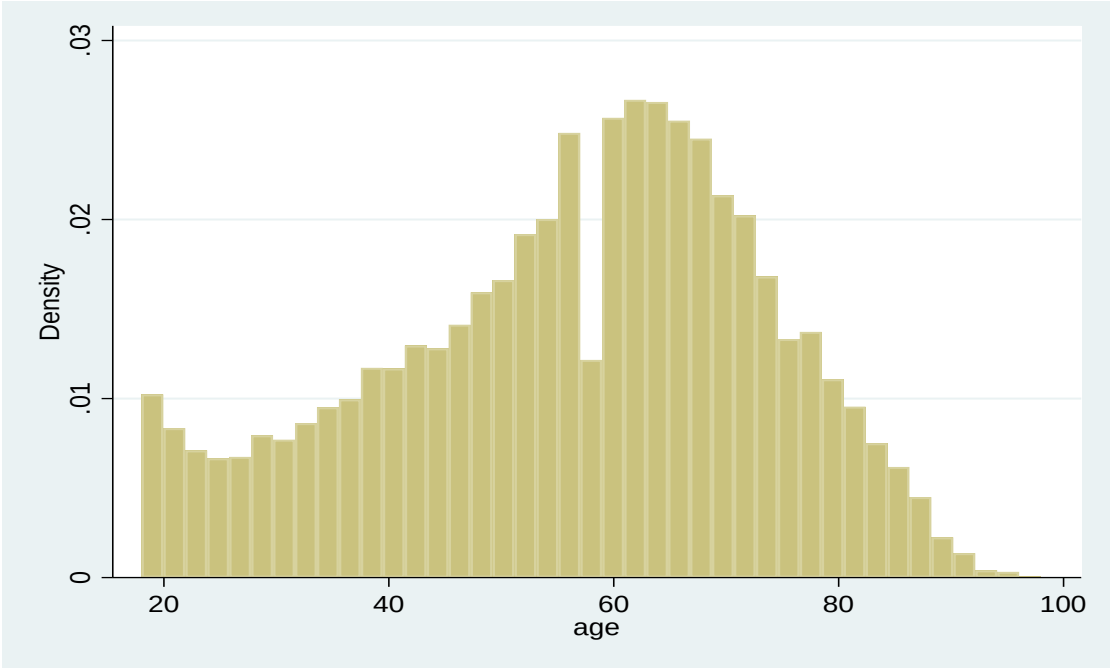


Chart 5. Age distribution of the ACT adult population 2014



Source: Australian Bureau of Statistics 2014 mid-year population estimates)

Chart 6 Age distribution of the ACT General Health Survey (2007-2016)



RDD and Kish Grid are used to select respondents. Kish Grid is a widely used technique in surveys and referred as the gold standard to select household members.(30) In telephone surveys, the next-birthday method is usually preferred to the Kish Grid sampling. (31) A research paper compares different

CATI sampling frames and found no single strategy is superior to any other at the general population level but RDD resulted in lower response rate than the other methods. (32)

Although the mobile frame is expected to recruit more young people than the landline frame, there are still sub-populations that are not covered by the GHS. These include people who do not own a phone or cannot speak English. Prior to 2012, residents who did not have a landline, usually young people, would have been overlooked. From 2012, this includes anyone who does not have a phone or people from a socially disadvantaged background, and those who do not speak English as the survey is only conducted in English. In 2011, over 18% of the ACT population speak a language other than English at home, with 3% of the total population speak English not well or not at all. (33)

- Recommendations

Small sample size is a common concern raised by stakeholders, who have suggested increasing the number to reduce sampling error. Consultants also recommended reducing the frequency of the surveys and/or limit the survey to adults only, given children are well covered by other surveys in the HSP. Another suggestion is to combine GHS data routinely with NHS data, ensuring standardised questions across both. In addition, because of the low mobile frame sample in ACT, alternative solutions should be explored such as geographical and/or online sampling or closer alignment with the NSWPHS. (14)

Timeliness

Conducted annually, the GHS collects timely data from the sample population. Time taken from data collection to dataset submission can vary from 6 to 12 months. Usually, data collection occurs in November/December, with the dataset received by April the following year. However, the process can be delayed due to a later start in the year for administration, leading to later dataset submission then missing out on reporting deadlines in the following year. This is complicated by the same staff having to both manage the survey and analyse

the data. Frequency of data dissemination depends on the reporting requirements. For example, the CHO's report is published every second year while the Children's report is published every year. However, the CHO's report is moving towards a rolling version and therefore will demand more timely data from the GHS. To add a new dataset onto the HealthStats website, it normally takes 1-2 months to set up and seek approval for releasing.

➢ Recommendations

Workshop discussions have reviewed that limited capacity in staff and resources is the main barrier in improving efficiency in data collection and dissemination. Suggestions to improve this include to:

- separate project management role from data analysis role;
- maximise use of existing workforce by outsourcing some components of the program, e.g. liaising with contractors, MAE scholars, members in other sections such as in the research and evaluation team.

Coherence

There are some compatibility shared between the GHS data and other survey data. One of the examples was the nutrition questions in NHS and GHS as discussed in the *Simplicity* attribute earlier. There were also overlaps on the physical activity questions from these two surveys. Both surveys ask about whether the child watches TV, plays video or computer games and how many hours she spends on these activities. However, the questions in these two surveys have different targets. The GHS questions focus on the length and frequency spent on physical activity, while the NHS asks about the environment and setting including questions like 'How often is the TV off during meal times?' and 'How often is the child supervised when watching TV?'. Table 3 below provides a summary of the surveys (state and national) regarding height, weight, nutrition, and physical activity.

Table 3. Summary of surveys covering height, weight, nutrition, and physical activity

Question Module	Self-reported Height and Weight	Parent measured/ perceived height and weight	Measured height and weight	Nutrition	Physical Activity
ACTGHS – Adult	x			x	x
ACTGHS - Child		x		x	x
ACTPANS			x	x	x
ASSAD	x				x
KINDY SCREEN			x	x	x
NHS			x	x	x
GSS					x

*ACTPANS: ACT Year 6 Physical Activity and Nutrition Survey

ASSAD: Australian Secondary Schools Alcohol and Drug Survey

Kindy Screen: Kindergarten health check

GSS: General Social Survey

NDSHS: National Drug Strategy Household Survey

- Recommendations

To improve the compatibility and comparability between GHS and other surveys, stakeholders have suggested alimenting between national data collections and that of the jurisdictions, or among alternative data sources. Having consistent questions would also mean the data could be pooled across surveys, which would boost sample sizes for analysis, and minimise the need to increase the sample size within the GHS, thus can save resources including time and money.

One possible solution could be that state, territory, and national bodies agree on the core components of their population health surveys for the same questions, but allow differences in the supplementary components for each jurisdiction's interest. In this way, at least some of the population health survey data are

comparable across jurisdictions. It also means that state and national data could potentially be combined.

4.7 Conclusion

In summary, the GHS is a useful surveillance tool to monitor trends of overweight, obesity, nutrition and physical activity for adults and children in the ACT. It is meeting its stated goals and the data collected are used for various purposes, including providing evidence to inform and develop reports and policies, and creating awareness of overweight, obesity and unhealthy physical and dietary behaviours. Data users and stakeholders seem satisfied with the system in general and agrees it plays a key role in monitoring population health for a small jurisdiction. However, improvements could be made in a few areas, including: developing a proper evaluation plan and a data quality statement, increasing the sample size and the proportion of young people in the sample population.

4.8 Appendices

Appendix 1. Information Sheet for Stakeholders

Introduction of General Health Survey

Since 2007, the General Health Survey has been conducted annually to collect health related information to monitor the health of the ACT population. Data are collected over various topics including health behaviours, health status, use of health services and other associated factors.

Purpose of this project

The project is a pilot study for the formal review of the whole survey program being undertaken by the Epidemiology Section; and to fulfil the Master of Applied Epidemiology (MAE) requirements in evaluating a surveillance system. The aims of this evaluation are to:

- document the operation of the system; and
- assess the performance of the survey as a surveillance system to monitor overweight, obesity, nutrition and physical activity for the ACT population.

Stakeholder consultation

We would like to engage key stakeholders in this evaluation and would appreciate if you could share your thoughts on the following questions:

1. How have you used the survey results?
2. Is it meeting your current needs?
3. Do you have other needs in monitoring weight status, nutrition and physical activity you would like the survey to address in the future?
4. How could the system be improved?

Appendix 2. Key questions, methods and analysis used to assess each attribute

ATTRIBUTE	Key questions	Methods	Analysis
Usefulness	What are the data used for? Who are the data users and how do they use the data?	Key informants interviews Review of reports generated from data Stakeholder consultation	Assess against stated aims and objectives of the survey
Simplicity	How many steps are the data go through? What type of information do the questions collect? How many questions for each component? Are questions different from other surveys?	Key informants interviews Review of survey questions Review of NSW Health website	Document steps involved to gather data Compare questions from other surveys
Stability	Is there any changes occurred in the operation? Are questions consistent over time? What happens if guidelines change? How often do the questions get reviewed and updated?	Key informants interviews Stakeholder consultation	Identify data fields collected from different years
Acceptability	What is the response rate? Are data users satisfied with the use of the survey? What are the completeness of data fields?	Stakeholder consultation Review of published reports Workshop discussions	Data analysis on call outcome reports
Data quality	Are the questions collecting what intend to measure? What guidelines are used to frame the questions?	Key informants interviews Workshop discussions	Data analysis of GHS dataset. e.g. % of missing fields

Sensitivity/ accuracy	How accurate to use self-reported data to measure BMI, nutrition and physical activity? Does it detect changes over time?	Literature review Data analysis	Data analysis of GHS dataset Comparison with other measures/ datasets. e.g. NHS
Representativeness	What is sample size? Is the age distribution in the sample reflect the real population structure? Who are not covered in the sample?	Review of reports generated from data Workshop discussions Literature review Stakeholder consultation	Data analysis of GHS dataset
Timeliness	How long does it take from data collection to data dissemination? How long takes for datasets to be added on HealthStats website? How often do data results get reported?	Key informants interviews Workshop discussions	Assess time taken for each step from collection to dissemination
Coherence	Are GHS data compatible with other survey data? What other surveys collects info on height, weight, nutrition and physical activity?	Review of survey questions in the NHS and the ACT survey program Workshop discussions	Compare what data fields were collected between the GHS and others

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Appendix 3: Numbers of questions and measurements for each subject

Subject (number of questions=n)	**Measurements**
Adults' height (n=1)	centimetres or feet and inches
Adults' weight (n=1)	kilogram or stones and pounds
Adults' nutrition (n=16)	-
Daily number of serves of vegetable and fruit	serves per day/week
Knowledge of recommended vegetable and fruit serves	serves per day/week
Frequency of consuming bread, breakfast cereal, pasta, meat products, fried potatoes, salty snacks, fast food, red meat	times per day/week
Cups of fruit juice, water, type of milk, sweetened sugary drink consumed	cups per day/week
Adults' physical activity (n=10)	-
Frequency of walking, vigorous chores, gardening/heavy yard work, vigorous and moderate exercise	hours and minutes /week
Children' height (n=1)	centimetres or feet and inches
Children' weight (n=1)	kilogram or stones and pounds
Children's nutrition (n=16)	-
Daily number of serves of vegetable and fruit	serves per day/week
Knowledge of recommended vegetable and fruit serves	serves per day/week
Frequency of consuming bread, breakfast cereal, pasta, meat products, fried potatoes, salty snacks, fast food, red meat	cups per day/week
Cups of fruit juice, water, milk, yoghurt, sweetened sugary drink consumed	serves per day/week

Sweet and savoury snacks, confectionary	times per day/week
Children's physical activity (n=16)	**-**
Physical activity over 7 days	days, hours, minutes
Sports and outdoor activities in last 12months	chosen from selected list
Recommended physical activity each day	minutes
Frequency of watching TV or DVDs during week and weekends	days, hours, minutes
Frequency of playing video or computer games during week and weekends	days, hours, minutes

4.9 References

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CHAPTER 5 – An outbreak of gastrointestinal illness in a national institution function

5.1 Prologue

5.1.1 Study rationale

On 14 June 2015, the Australian Capital Territory Health Protection Service (HPS) on-call officer was notified of a possible gastroenteritis outbreak among people who attended a dinner function at a large national institution in Canberra. Five staff of the institution were absent with diarrhoea following the function, in addition to two similar complaints from public members. The HPS convened an acute response team to investigate and identify the cause of this gastrointestinal illness outbreak and implement appropriate public health measures to prevent further cases.

5.1.2 My role

I had various roles as a member of the response team investigating this outbreak. My contribution included conducting interviews with staff and public members who attended or worked for the function, discussing what study type to use for the investigation, assisting selecting controls matched with cases and coordinating tasks among team members to interview staff. I also entered data into a Microsoft Excel file and analysed the data using Stata version 14. In addition, I contributed in discussions and meetings on study design and data analysis with the rest of the response team.

5.1.3 Lessons learnt

This outbreak occurred during my first year of MAE and was a great experience to participate in the investigation. I gained skills in working as part of a multi-disciplinary team, learning how important to communicate effectively with all team members and clarify individual tasks and responsibilities. I learnt how to critically analyse results and limitations generated by different study designs. I also learnt the techniques to administer a questionnaire and how to approach different people to collect data via telephone interviews.

One of the important skills I learnt was how to clean, manage and analyse data. Having an accurately recorded dataset is essential before conducting analysis.

In the process I learnt how to use Microsoft Excel and Stata to analyse data. I also learnt what statistical test to use in measuring the strength of association in different study designs. Another lesson I learnt was there was no perfect study for investigating an outbreak and the best is to find one that has a good balance between theoretical and practical restraints. For example, it would be ideal to conduct a cohort study for this outbreak, but it was impossible to trace every attendee. Meanwhile, because the illness was self-limited and had a short duration, investigators needed to act quickly to identify the source and stop further transmission.

5.1.4 Public Health Implications

The findings of this investigation add to the existing knowledge of *C. perfringens* outbreaks in Australia. The evidence suggests that a break down in hygiene, temperature control and food handling practices may have resulted in this food poisoning. It highlights the potential food safety risks associated with large scale food service and the imperative for safe food practices, particularly relating to cooling and reheating meats to prevent the proliferation of *C. perfringens*.

5.1.5 Acknowledgements

I wish to acknowledge the following persons and organisations of their assistance with the investigation: Laura Ford, April Witteveen, Rebecca Hundy and Sam Kelly at the Health Protection Services, ACT Health; Bridget O'Connor and Hai Phung at the Epidemiology Section, ACT Health; Lucas Mills, second year MAE student placed at HPS; Rosemary Korda at the National Centre of Epidemiology and Population Health, ANU.

5.2 Abstract

C. perfringens is a commonly identified cause of gastroenteritis outbreaks worldwide and in Australia. On 14 June, the HPS was alerted to a possible gastroenteritis outbreak among staff and public members who attended a dinner function at a large national institution in Canberra. This study aimed to describe the epidemiology of investigating and identifying the cause of this gastrointestinal illness outbreak.

We conducted two studies: a retrospective cohort study and a case control study. In the cohort study, participants consist of staff who worked at the dinner function. In the case control study, all cases found in staff and public members were included. Cases and controls were matched by sex, age group and group status. Data were collected via telephone interviews using a structured questionnaire and analysed using Stata 14.

With an 80% response rate, 45 staff members who consumed the function food were included in the cohort study for analysis and 16 of them were cases. Butter chicken (adjusted odds ratio = 5.19, 95% CI 1.08-24.92, p=0.04) and eating at or after 9pm (aOR=10.08, 95%CI 1.03-98.81, p<0.05) were found to have significant associations with illness in the cohort study. In the case control study, rice remained significantly associated with illness (aOR=5.21, 95%CI 1.07-25.23, p=0.04) after adjusted for possible confounders.

The epidemiological, laboratory and environmental evidence were consistent that *C. perfringens* was the mostly likely cause of this outbreak. Butter chicken and rice were suspected vehicles of transmission of the bacterium. The results of investigation suggest that a breakdown in temperature control and food handling practices may result in the bacterium to grow rapidly and produce a toxin which caused the illness.

5.3 Introduction

Usually found on raw meat and poultry, *Clostridium perfringens* is a bacterium from many environmental sources and in the intestines of humans and animals. It grows in conditions with very little or no oxygen, and under ideal conditions it can multiply very rapidly. (6) There are five strains of *C. perfringens,* each strain producing a different profile of toxins, and human illness is mostly caused by the production of *C. perfringens* enterotoxin (CPE). (7) *C. perfringens* has a reported incubation period of 6–24 hrs, and causes self-limiting symptoms of diarrhoea, nausea and abdominal cramping, with illness usually resolving within 24 hrs.(8) Spores of the *C. perfringens* toxin bacterium survive normal cooking

temperatures and can multiply during slow cooling, storage at ambient temperatures, and/or inadequate reheating. (8)

C. perfringens is a commonly identified cause of gastroenteritis outbreaks worldwide and in Australia. (1-5) A recent U.S report estimates that *C. perfringens* is the second most common bacterial cause of food poisoning. (9) Circa 2010, there were an estimated annual 16,500 episodes of domestically acquired foodborne gastroenteritis caused by *C. perfringens* in Australia. (10) However, *C. perfringens* infection is not a notifiable disease in any jurisdiction in Australia. Therefore, our understanding of the disease relies heavily on the data collected through outbreaks within and outside Australia.

The HPS was alerted to a possible gastroenteritis outbreak among staff and public members who attended a dinner function at a large national institution in Canberra on 14 June. Five staff members of the institution were reported absent with diarrhoea following the function. The institution then also received separate complaints from two members of the public reporting similar symptoms. The dinner function held at the venue on 12 June was the only known common exposure, attended by an estimated 2000-3000 people. An acute response team was summoned to manage the outbreak and investigate the possible source.

5.4 Methods

Cohort study design is the preferred study design if feasible, as we had a defined list of staff members to follow up. However, for the public members, the RSVP list is very long and there were only a small number of cases, hence a case control study was considered most appropriate. We conducted two studies - a retrospective cohort study among staff and a case control study among staff and members of the public.

5.4.1 Cohort Study

Selection of participants

Participants for the cohort study consisted of all staff members who worked at the dinner function on 12 June. A list of their names and phone numbers were

provided by the manager of the institution. The investigation team attempted to contact everyone on the list and interview the respondents.

Outcome and exposure

Self-reported diarrhoea (one or more episodes of loose stools within 24 hours) was the outcome of the cohort study with consumption of function food as exposure.

5.4.2 Case-Control Study

Selection of participants

Cases and controls were selected from staff members who worked at the function and members of the public RSVP to attend. However, to timely estimate the outbreak scale, only the first 100 names on the RSVP list by alphabetic order of family names were contacted.

Cases and controls

A case was defined as a person among staff members and members of public who consumed the function food served at the venue on 12 June and subsequently experienced one or more episodes of self-reported diarrhoea within 24 hours. A ratio of 1:1 between case and control was used. A control was defined as a person among staff members and members of public who consumed the function food at the venue on 12 June and did not subsequently experience diarrhoeal within 24 hours. Controls were randomly selected by using the RANDBETWEEN function in Microsoft Excel to generate random numbers. Cases and controls were frequency matched by sex, age group (child/adult) and group status (staff or public members).

5.4.3 Environmental Investigation

Environmental Health Officers contacted the institution to ascertain whether similar food to the function was served at the on-site café, and to keep aside the leftover function food for testing. They conducted an inspection on the on-site café that provided the function food and collected food samples of leftover rice, butter chicken, stroganoff, macaroni and mashed potato from the kitchen for lab testing.

5.4.4 Data collection and analysis

For both studies, data were collected using modified version of the standard ACT OzFoodNet gastroenteritis questionnaire so all menu items at the function were included. Participants were contacted and interviewed through telephone with two attempts in one day. The questionnaire collects information on demographics, clinical symptoms, food consumption time, and food history. (Appendix 1).

Data were entered and stored in Microsoft Excel. Stata version 14 was used to perform descriptive and analytical analysis. All food items and eating time were included in the univariate analysis. Variables which had a p-value <0.1 in the univariate analysis, as well as age and sex, were then included in the multivariate analysis. The likelihood ratio test and Hosmer-Lemeshow test were used to assess variable contributions and compare model fitness. Results were reported using relative risks or odds ratios with 95 per cent confidence intervals (CI) and p values. A p-value <0.05 was considered to have a statistically significant association with the outcome in the final model.

5.5 Results

It was estimated that a total of 2000-3000 people attended the dinner function held at the institution on 12 June. During the interviews with the member of the public, it became apparent that not everyone on the RSVP list ended up attending and among those who attended, some of them did not consume any food at the venue. The function ran from 4.30pm to 9pm and food was served at three stations around the building, two outdoors and one indoor. There were separate menus for children and adults. The children's menu included fish, nuggets and chips, and the adults' menu included beef stroganoff, butter chicken, macaroni cheese, rice and vegetables. Majority of the staff members consumed the left over function food - butter chicken, rice and beef stroganoff - when the function concluded at 9pm.

5.5.1 Epidemiological studies

Cohort Study

The investigation team interviewed 72 of 90 staff who had worked at the function (80% response rate). Of the 72 staff members interviewed, 45 ate the function food so were included in the cohort for analysis. There was one staff member who was having diarrhoea before the function and was not included in the study. He was ruled out as a possible source of transmission because he did not work in a catering role nor eat/contact the function food; therefore his chance of contaminating others was assessed to be minimal. The median age of the study participants was 26 years (range 16 – 58) with 58% males.

Of the 45 people who ate the function food, 16 were classified as cases, an illness attack rate of 35.6%. Food was served throughout the night, with 29% of the cohort eating before 9pm and 71% eating after the function (9pm or later). Dates of onset for cases ranged from 12-14 June with almost half of cases experiencing symptoms before midnight of 13 June. (Figure 1) Cases were suffering from diarrhoea, along with abdominal cramps, nausea, fever, or headache. (Table 1) The median incubation period was 12.5 hrs (1.5 hrs – 29 hrs) and the median duration of illness was 7 hrs (<1hrs – 24 hrs).

Figure 1. Epidemic curve of cases by date and time of symptom onset in staff cohort study

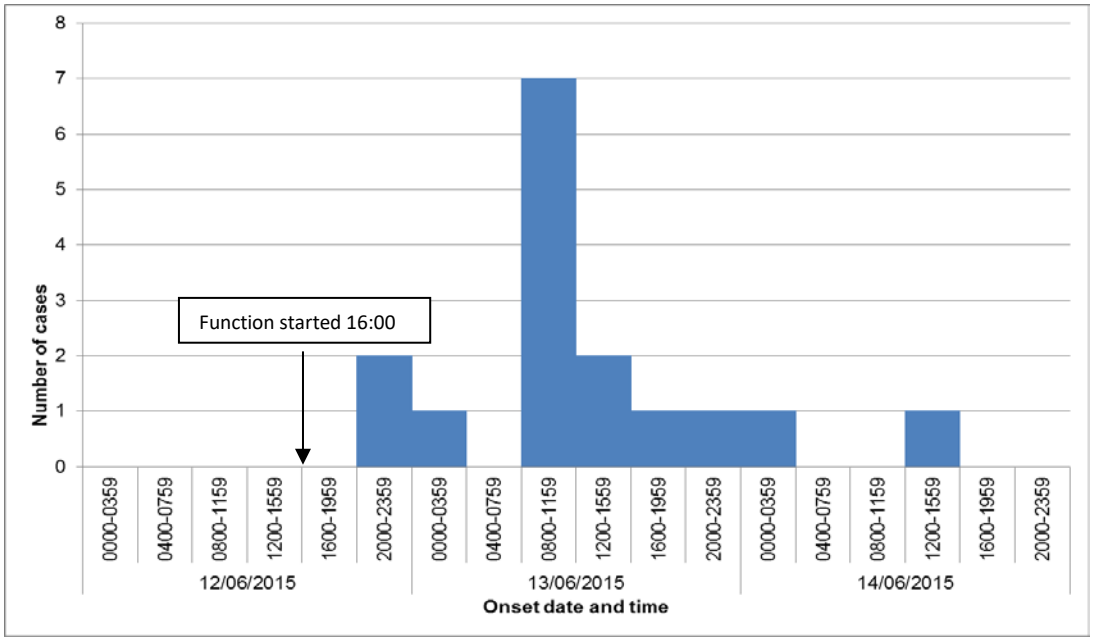

Table 1. Characteristics of cases and non-cases in staff cohort study

Characteristics	Cases = N (%)	Non-cases = N (%)
Total	16 (35.6)	29 (64.4)
Sex		
Female	7 (43.8)	12 (41.4)
Male	9 (56.3)	17 (59.6)
Age group		
16-29	10 (62.5)	15 (51.7)
30-59	6 (37.5)	14 (48.3)
Symptoms		
diarrhoea	16 (100.0)	0
abdominal cramps	14 (87.5)	N/A
nausea	6 (37.5)	N/A
fever	4 (25.0)	N/A
headache	4 (25.0)	N/A
body and muscle aches	2 (12.5)	N/A
chills	1 (6.3)	N/A
vomiting	1 (6.3)	N/A
fatigue	1 (6.3)	N/A

Univariable analysis showed that butter chicken (relative risk=3.17; 95%CI 0.87-17.32; p=0.06) and eating at or after 9pm (RR=6.09, 95%CI 0. 0.94-256.53, p=0.04) had strong associations with the illness. (Table 2)

Table 2. Univariable analyses showing association between illness and exposure

	Exposed			Not exposed			Relative risk	p-value
Exposure	**Cases**	**Total**	**Attack rate (%)**	**Cases**	**Total**	**Attack rate (%)**	**(95% CI)**	
Popcorn	1	1	100.0	15	44	34.1	2.93 (0.07-19.07)	0.35
Butter Chicken	13	26	50.0	3	19	15.8	3.17 (0.87-17.32)	0.06
Rice	10	22	45.5	6	23	26.1	1.74 (0.57-5.83)	0.29
Beef stroganoff	14	36	38.9	2	9	22.2	1.75 (0.42-15.86)	0.49
Boiled vegetables	1	3	33.3	15	42	35.7	0.93 (0.02-6.07)	1.04
Liquid Nitrogen Ice cream	1	8	12.5	15	37	40.5	0.31(0.01-2.00)	0.24
Macaroni and cheese	0	1	0.0	16	44	36.4	-	-
Fairy floss	0	0	0.0	16	45	35.6	-	-
Nuggets	0	6	0.0	16	39	41.0	-	-
Fish	0	4	0.0	16	41	39.0	-	-
Hot chips	0	5	0.0	16	40	40.0	-	-
Tomato sauce	0	1	0.0	16	44	36.4	-	-
Eating at or after 9pm	15	32	46.9	1	13	7.7	6.09 (0.94-256.53)	0.04

In the multivariable analysis, butter chicken, eating time, age and sex were included in the final model. Adjusted for age and sex, butter chicken (aOR = 5.19, 95% CI 1.08-24.92, p=0.04) and eating at or after 9pm (aOR=10.08, 95%CI 1.03-98.81, p<0.05) remained strongly associated with the illness. (Table 3) Results of the association between butter chicken and the illness were stratified by rice and eating time respectively, but none of them were statistically significant. Rice was examined to be a confounder but was not included in the final model based on the results from model fitness tests.

Table 3. Multivariable logistic regression showing association between illness and exposures

Exposure	Adjusted OR	95% CI	P-value
Butter chicken	5.19	1.08-24.92	0.04
Eating time	10.09	1.03-98.81	<0.05
Sex	1.01	0.23-4.48	0.98
Age	0.96	0.19-4.77	0.96

Case-Control

A total of 72 staff members and 62 members of the public were interviewed, of whom 29 (16 staff members and 13 members of the public) were classified as cases. The median age of the participants was 33 years (range 2-58), 49 (84.5%) of whom were adults (age > 18) and 32 (55%) were males. Symptoms and dates of onset experienced by cases were very similar to those in the cohort study (Figure 2 and Table 4). The median incubation period was 12.5 hrs (1.5 hrs – 29 hrs) and the median duration of illness was 8 hrs (<1 hrs – 48 hrs), which was also similar to those in the cohort study.

Figure 2. Epidemic curve of cases by date and time of symptom onset in case control study

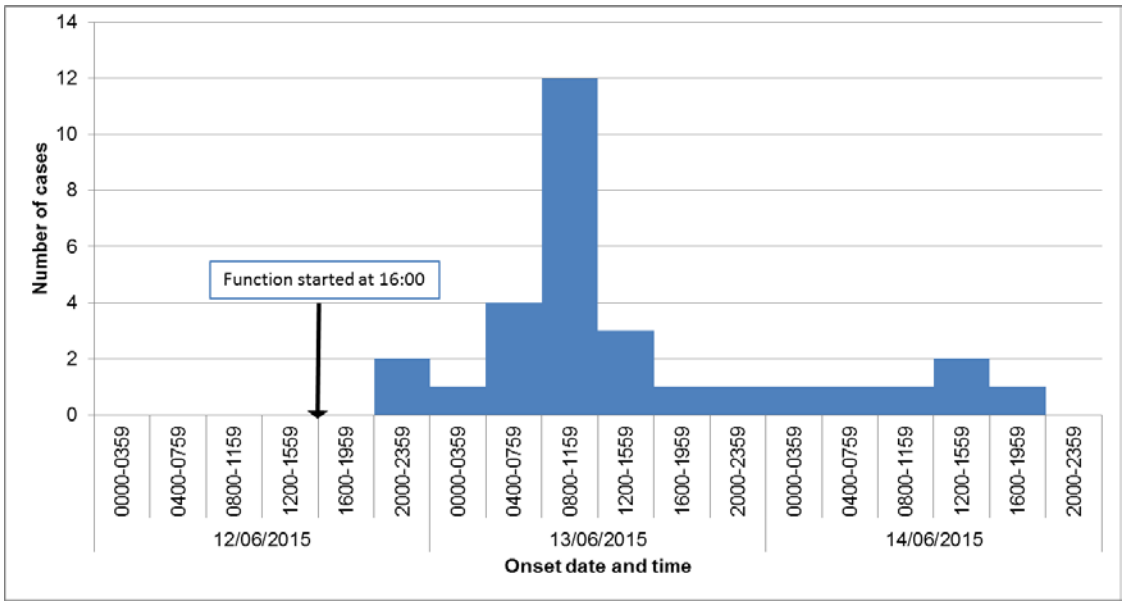

Table 4. Characteristics of cases and controls in case control study

Characteristics	Cases = N (%)	Controls = N (%)
Total	29 (50)	29 (50)
Sex		
Female	13 (44.8)	13 (44.8)
Male	16 (55.2)	16 (55.2)
Age group		
Child	6 (20.7)	4 (13.8)
Adult	23 (79.3)	25 (86.2)
Symptoms		
diarrhoea	29 (100.0)	0
abdominal cramps	23 (79.3)	N/A
nausea	10 (34.5)	N/A
fever	5 (17.2)	N/A
headache	4 (13.8)	N/A
body and muscle aches	2 (6.9)	N/A
chills	4 (13.8)	N/A
vomiting	1 (3.5)	N/A
fatigue	3 (10.3)	N/A

In the univariable analysis, menu items were adjusted for age group (child/adult), sex and group status (public or staff), as these were matching factors. (Table 5) Variables that had a p-value <0.1 were then included in the multivariable analysis.

Final model of the multivariable analysis included macaroni cheese, butter chicken, rice, beef stroganoff, age group, sex, group status and eating time. Results showed that rice had a strong association with the illness (aOR=5.21, 95%CI 1.07-25.23, p=0.04) after adjustment for age, sex, group status, eating time, and other food items in the model. (Table 6) When stratified by butter chicken or eating time separately, the associations between rice and the illness were not statistically significant.

Table 5: Univariable analyses showing association between illness and exposure, adjusted for age group (child/adult), sex and group status (public/staff)

Exposure	Cases	Controls	OR	95%CI	P value
	N (%)	N (%)			
Nuggets	6 (21)	11 (38)	0.26	0.06-1.16	0.08
Fish	4 (14)	10 (34)	1.19	0.04-0.91	0.04
Hot chips	6 (21)	10 (34)	0.36	0.09-1.49	0.16
Tomato sauce	4 (14)	6 (21)	0.38	0.06-2.27	0.29
Butter Chicken	21 (72)	15 (52)	3.29	0.97-11.22	0.06
Beef stroganoff	23 (79)	16 (55)	4.23	1.13-15.77	0.03
Boiled vegetables	10 (34)	7 (24)	4.17	0.68-25.72	0.12
Rice	23 (79)	13 (45)	6.48	1.74-24.06	0.01
Macaroni and cheese	1 (3)	7 (24)	0.06	0.01-0.65	0.02
Fairy floss	4 (14)	3 (10)	1.52	0.26-8.89	0.64
Popcorn	1 (3)	1 (3)	1.10	0.06-18.97	0.94
Liquid Nitrogen Ice cream	5 (17)	7 (24)	0.78	0.19-2.46	0.92
Ate at or after 9pm	15(52)	10(34)	4.16	0.67-25.79	0.13

Table 6: Multivariable logistic regression showing association between illness and exposures

Exposure	Adjusted OR	95%CI	P value
Butter Chicken	1.49	0.32-7.01	0.62
Beef stroganoff	2.17	0.44-10.62	0.34
Rice	5.21	1.07-25.23	0.04
Macaroni and cheese	0.08	<0.01-0.97	<0.05
Group status	0.21	0.01-2.99	0.25
Age	0.24	0.03-2.08	0.20
Sex	1.23	0.31-4.89	0.77
Eating at or after 9 pm	6.58	0.51-85.59	0.15

5.5.2 Environmental and Laboratory investigations

The EHOs conducted an inspection on the on-site café and found that some of the same menu items, including butter chicken and beef stroganoff, were served on the morning of 13 June for café customers, but had been withdrawn since the notification. The investigation further revealed that the food preparation for the function started on Tuesday 9 June and the chicken was precooked on Wednesday 10 June. Sauces were added to meats on Thursday 11 June and the reheating started on midday Friday 12 June. Other function food items including rice, chips, and nuggets were cooked on the day of the function. There was a high turnover of the food at the function with food being replenished approximately every 15 minutes.

Food safety inspection carried out by EHOs suggested that food handling practices and temperature control may have resulted in contamination of the food. The food temperatures were not taken after cooking and before serving at the venue. The EHOs collected food samples of leftover rice, butter chicken, stroganoff, macaroni and mashed potato from the kitchen for lab testing. Preliminary tests found a heavy growth of *C. perfringens* in the sample of butter chicken. Final results showed that the sample contained *C. perfringens* of 8.4 x 10^5 CFU per gram, which is far beyond the 'potentially hazardous'

category(≥10^4 CFU per gram) identified by the Food Standards Australia and New Zealand. (11) A further genotyping revealed that the butter chicken was carrying *C. perfringens* toxin Type A with a IS1470-like plasmid located *C. perfringens* enterotoxin (CPE) gene and a chromosomally located CPE gene.

5.6 Discussion

Interpretation of the epidemiological, environmental and laboratory evidence suggested the outbreak was caused by *C. perfringens* toxin Type A, with the likely vehicles of transmission being the butter chicken (cohort study) and rice (case control study). The clinical features of the illness amongst cases in this outbreak were consistent with *C. perfringens* intoxication as described in the literature. (1, 3, 8, 9) The incubation period and duration of symptoms were short: a median of 12.5 hrs and 7-8 hrs, respectively. Though there were 3 cases which had an incubation period less than 4 hrs and 1 case longer than 24 hrs, most of the cases fell into the normal range of 6-24 hrs. Symptoms were also typical, with all cases experiencing diarrhoea and most of them having abdominal pain.

The discrepancy in results - that *C. perfringens* was not detected in the rice and the rice did not have a significant association with the illness in the cohort study but it had a strong association in the case control study - can be possibly explained by several factors. These include a lack of power in the cohort study (note elevated risk with wide confidence interval), and/or that a batch of contaminated rice was only served before 9pm. In the cohort study, almost all staff ate after the function (9pm later on) so they might have consumed little or none of the contaminated rice or the rice tested was not from the contaminated batch.

There are limitations and biases in the epidemiological studies. The investigation team was not able to obtain human samples to confirm the possible enterotoxin. This is likely due to the illness being mild and self-limiting with a short duration, so no case sought medical attention or was willing to submit a faecal specimen. Potential selection biases included that people who

became ill were more likely to participate in the study than those who did not. This would mean the attack rate might be overestimated; however, this bias is less likely to affect the internal comparisons (i.e. effect size estimates). Another selection bias might be that non-respondents were too sick to respond, which would suggest the attack rate might be under estimated.

In terms of measurement biases, there may have been some misclassification of cases, as this was based on self-reported symptoms. The definition of ‘diarrhoea’ was not specified during the interview on the assumption that people would understand of what ‘diarrhoea’ means. However, the interpretations of diarrhoea might vary by participants. In order to increase sensitivity to capture the max number of cases, the threshold of ‘diarrhoea’ used in this outbreak (≥1 episode) was lower than commonly used one ((≥3 episodes). This would suggest the results might not be comparable with other studies. Another potential measurement bias in both studies is recall bias. Cases may be more likely to remember what they ate at the function, or have preconceived ideas about what caused the illness. Also, most of the participants were interviewed a couple of days after the event, so there were some degree of inaccuracy in recalling the food history. In addition, most of the participants attended the function as a family group and adults answered the questionnaire on behalf of their children, so it was difficult to recall precisely what each person had at the function, especially when there were separate menus for adults and children.

Efforts were made to minimise these biases in the investigation. A quick training and drill interviews were provided by experienced epidemiologists for new members joining the team. A validated and structured questionnaire was used to collect data via interviews. In addition, interviewers were blinded to the suspected food items and most of the initial contacts with participants were made during the first three days after alert was notified. Techniques that can be employed in future investigations to minimise recall bias include use of the Internet such as social media or online surveys to reduce the time gap between notification and being interviewed. One study suggested internet surveys are

likely to become more common in epidemiologic investigations and have the potential to rapidly provide data to enable appropriate public health actions. (12)

Group discussions were held by surveillance manager, epidemiologists and MAE students on what study type to use for the investigation. Cohort study design was preferred and feasible for staff members. But due to the small number of cases of the public members, case control study was then considered for efficiency reasons. The initial two options were A) cohort study among staff members B) case-control study among members of the public. It was not a straightforward choice as either option had its potential problems. Option A is preferred and feasible, but we would need to conduct over 70 interviews in the next day or two, which would be challenging given the shortage in staff and a low attack rate to justify requesting more resources. Option B is efficient, but we only had a small number of cases from the members of the public, so the study might not achieve any meaningful results. But we could combine both cases of staff members and members of the public to increase the study power, and frequency matching age, sex and group status (public/staff). This was also the reason why there were overlaps (16 cases of staff members) between the cases in the cohort study and the case- control study. Next day, we were given more team members to undertake interviews, so decision was made to conduct both studies for my MAE project as a methodological exercise. We were also interested to know whether the two studies would produce similar results and the value of conducting a second study for one investigation.

To improve future outbreak investigation process, we should consider using the Internet as an effective tool to recruit participants and collect data. As mentioned earlier, one of the reasons for the discrepancy in results was lack of power in the study. Increasing the number of participants could possibly prevent this problem by using emails, social media or online survey. This can also shorten the data collection time and minimise the privacy concerns people have. During the telephone interviews, people were more concerned to provide personal details to strangers, especially with regards to their children. If they

were given the option to remain anonymous while providing the data, they might feel safer or more comfortable to do so. Social media or online survey can also play a critical role in contact tracing, especially for diseases that are highly infectious and require urgent response.

5.7 Conclusions

This report detailed an outbreak investigation of *C. perfringens* that occurred among staff and public members at a large national institution in Canberra. The epidemiological, laboratory and environmental evidence were consistent with *C. perfringens* as the cause of this outbreak, and butter chicken and rice as the possible vehicles of transmission. The findings of this investigation suggest that a breakdown in temperature control and good food handling practices may have resulted in *C. perfringens* bacterium growing rapidly and producing a toxin which caused the illness. In order to prevent similar outbreaks in the future, caterers need to ensure that the staff are adequately trained and employing appropriate food preparation and handling practices, such as use of the temperature control thermometers, to reduce potential risks when catering for larger groups.

Our practice suggests that the value of a second epidemiological study seems questionable given limited time and resource available. Although the two studies identified different suspected food vehicles, the bacterium and case characteristics such as incubation period, symptoms and duration of illness were very similar and suggestive of a possible common source. However, it did identify another possible vehicle for the transmission, which would not be known otherwise; and covered a different sub-population for the outbreak. Therefore, it is necessary to assess the pros and cons when choosing an appropriate study for investigating an outbreak.

5.8 Appendices

Appendix 1: Structured questionnaire for the outbreak investigation

Confidential – for public health use only - *CASE / NOT CASE* - *ENTERED? Y / N* - *NO.:___*

Pt surname: _____

OUTBREAK INVESTIGATION CASE QUESTIONNAIRE

Questacon

Interviewer:_____	Time	Outcome
1	___ / ___ / _____	_____ am / pm	_____
2	___ / ___ / _____	_____ am / pm	_____
3	___ / ___ / _____	_____ am / pm	_____
4	___ / ___ / _____	_____ am / pm	_____

Call Outcomes
OC1 – No Answer
OC2 – Subject not home, call back
OC3 – Appointment to call back
OC4 – Refusal
OC5 - Interviewed

'Hello. My name is _____ and I'm calling from ACT Health.' How are you today?

'We are currently investigating an increase in the number of gastroenteritis infections in the community and we are trying to find the potential source for this infection. We are interested in if you ate out at all over the weekend. But our first point of call was a list of names of people who were at Questacon on Friday night (that's where we got your number from). Did you go? We'll also ask you about other places you went to over the weekend.

We would like your assistance in answering some questions regarding your (or case's name) illness and foods eaten before becoming ill. It should only take 10 – 15 minutes to complete.'

'The information from this survey is confidential and is being collected in accordance with the Public Health Act 1997. Only authorised officers from ACT Health will be involved in examining the information. In the same way, we are limited in the information we are able to feed back to you '

Personal details

First Name: _____ Address: _____

Last Name: _____ Suburb: _____

Telephone: _____ (Home) _____

_____ (Work) Post Code: _____

Date of Birth: _____ / _____ / _____ Age: _____ Sex: Male / Female

So, you went to Questacon over the weekend?	Yes / No Did you attend the members night on Friday? Yes / No

Who did you go to it with?	1. Sex: Age: 2. Sex: Age: 3. Sex: Age: 4. Sex: Age: 5. Sex: Age: *(NB need a questionnaire for each case)*
Just to confirm you were a visitor:	Visitor Y N *(NB not Questacon staff / Catering staff)*
If staff, what was your role on the night?	
If food handler, were you ill prior to the event?	

So, let's talk about what you got up to when you were at Questacon?

Exposure information

What date and time did you eat?	Date: _____ Time: _____
Where did you get your food from:	• Inside Yes / No • outside (Library side) Yes / No • outside (Gallery side) Yes / No • MegaBites Cafe Yes / No

	Yes	*No*
• Nuggets		
• Fish		
• Chips		
• Tomato		

Sauce		
• Butter Chicken		
• Beef Stroganoff		
• Vegetables		
• Rice		
• Macaroni & cheese		
• Fairy Floss		
• Popcorn		
• Liquid Nitrogen Ice-Cream		
• Other		

Did you eat at any other commercial venues in Canberra over the weekend?	Yes / No
If yes:	Where: _____ Date: _____ Time: _____ What did you eat?
If yes:	Where: _____ Date: _____ Time: _____ What did you eat?

Medical & diagnostic information

'We would like to obtain some detail on whether or not you became sick, and if so, what kind of symptoms you experienced.'

1. **Did (you / your child) experience any of the following symptoms?**

☐ NO ILLNESS

	Yes	No	DK/NS	Onset Date	Time of onset
Vomiting.....	☐	☐	☐	____ / ____ / _____	.....
Diarrhoea.....	☐	☐	☐	____ / ____ / _____	.....
Stomach Cramps.....	☐	☐	☐	____ / ____ / _____	.....
Nausea.....	☐	☐	☐	____ / ____ / _____	.....
Fever.....	☐	☐	☐	____ / ____ / _____	.....
Hot/cold Chills.....	☐	☐	☐	.....	.....
Other symptoms.....	☐	☐	☐	.....	.....

Specify: _____

2. **What was your first symptom?** _____

3. **For how long did the diarrhoea or vomiting symptoms last?** _____**hours**

	Yes	No	DK/NS	Specify	Location
4. **Did you consult a doctor for the illness?**	☐	☐	☐	_____	_____
5. **Were (you/ your child) admitted to hospital overnight?**.....	☐	☐	☐	_____	_____
	↳	Admission		____ / ____ / _____	Nights stayed ____
	↳	Discharge		____ / ____ / _____	
6. **Were any samples provided for pathology testing?**.	☐	☐	☐	_____	_____

IF SYMPTOMATIC PLEASE CONTACT APRIL SO I CAN ORGANISE FOR A STOOL SAMPLE TO BE COLLECTED - VERY IMPORTANT!!!!

In the 3 days prior to your illness…

	Yes	No	DK/NS	
7. Were any other family members sick with a similar illness prior to this event?	☐	☐	☐	
8. Did (you / your child) have contact with anyone with a similar illness prior to this event? (eg. friends, work colleagues).....	☐	☐	☐	
9. Do you know of anyone else in your neighbourhood, school, office etc. with a similar illness after the event?	☐	☐	☐	
	↓	→	→	Go to Q11/Q13

Name	Relationship	Address	Phone
1.			
2.			
3.			

Other notes:

5.9 References

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CHAPTER 6 -Teaching experiences

6.1 Prologue

6.1.1 Rationale

There are two teaching requirements as part of the Master of Philosophy in Applied Epidemiology (MAE) program; one was to prepare and deliver a lesson from the field (LFF) for the peer cohort; and the other was to prepare and conduct a teaching session for first year MAE students.

6.1.2 My role and lessons learnt

Lesson from the field (LFF)

My LFF stemmed from my MAE projects on analysing hospital data. As one of the highlights of my MAE experiences, learning and being able to prepare and conduct patient and visit analysis are valuable skills that are useful in all types of data analysis. How to work on a large administrative dataset was not covered in MAE courses. Therefore, I decided to conduct my LFF on basic analysis on hospital data to share my experience and skills with my peer cohort.

I enjoyed preparing and conducting my LFF. I found it was a rewarding experience when people appreciated how much they learned from the exercise. It was also a mutual learning process because by discussing answers with people, I learned new Stata commands that I was not familiar with before. A few lessons learned through conducting this LFF include:

- Precise wording to avoid misunderstanding. For example, ‘admission contributed to type 2 diabetes’, compared to ‘admission with primary diagnosis being type 2 diabetes’, the former can possibly include admissions from both primary and secondary diagnosis.
- Exchange do.files and discuss different approaches to understand why and how the answers varied. At end of the exercise, I circulated two do.files created by group members to demonstrate that how different commands can achieve same outcomes.
- Prepare the dummy dataset in different formats that can be opened or imported in old Stata versions.

I received positive feedback from all participants; some are quoted below:

"Thanks Cecilia that was awesome! I learned a couple of new commands that I can add to the arsenal."

"This was a great LFF Cecilia. I think I'll be doing some sifting through hospital data like this for my outbreak so very much appreciated!"

Teaching session for MAE16 cohort

Our cohort was required to conduct a half-day teaching session for first year MAE student during the 3rd course block, semester one 2016. Our cohort decided to split this half-day of teaching into three sessions and divided into groups accordingly. In addition to being in one of the groups, I also had the role of consolidating and summarising the evaluation forms for each session at the end.

Paul Dutton, Johanna Dups and I were responsible for conducting a session on differentiating between case-control studies and cohort studies in outbreak investigations. We held discussions on the structure, content and format of the presentation (Appendix 2). We allocated tasks in designing and delivering parts of the presentation. I also led an interactive discussion with the students by using my own outbreak investigation as a case study.

In preparing and delivering this session, I consolidated my knowledge and skills on the topic myself. I also enjoyed coordinating group discussions and working as a small team. In addition, my peer cohort created 13 surviving tips for the first year MAE students. It was a great opportunity to pass on some of the important tips and lessons we learned and experienced by ourselves.

We received an overall satisfaction for our teaching session through a group evaluation, 4.4 out of 5. The breaking down scores for each component of the session was listed below.

Table 1. Evaluation score for session

Item	**Average**
Content	4.3
Instructor presentation	4.5
Methods	4.7
Learnt something new	4.4
Engagement	4.4
Asking questions	4.5

Additional comments included:

“Session was great as above. Don’t be afraid to go into more detail!”

“Was helpful - knows the multitude of factors when designing studies.”

“Would have preferred the MAE scholars to tell about the projects as casual interaction which allowed questions be asked. At this point a bit over hypothetical case studies.”

“Any other common studies, such as nested studies, would be great. Just so we are aware of their existence!”

“Maybe didn't need so many examples or put into groups + groups report back on their scenario + what method they choose. Quiz was good.”

6.2 Appendices

Appendix 1. Lesson from the Field

Lesson from the Field

Cecilia Xu – February 2016

Basic analysis on hospital data

This lesson from the field (LFF) exercise is a self-directed learning exercise and will be emailed out on **Friday 5 February**.
The teleconference is scheduled for **Friday 12 February** for **1:00pm EST.** The answers are due back on **Thursday 11 February.**
If anybody has problems during the teleconference, please call my mobile on 0424 152 086.

Instructions

This LFF will require you to use Stata to conduct data analysis. A data dictionary has been attached to the end of this document for your information. Instructions are highlighted with **red titles**, questions are in **blue**. Stata commands are in Courier New font (this font is Courier New).

Learning objectives

By the end of this LFF you should be able to:

- **identify key variables in administrative hospitalisation data.**
- **use and interpret ICD coding to select particular conditions.**
- **differentiate between episode-based vs patient-based analysis; and**
- **calculate**
    - **number and proportion of particular conditions based on episodes and on patients;**
    - **age and sex distribution of particular conditions based on episodes and on patients.**

Note: The data set provided in this exercise is fabricated data. It is not publicly available and should not be disclosed outside of this LFF.

Scenario

You have just arrived at the Epidemiology Section at ACT Health in Canberra as the new MAE student. It is the busy time of the year as the whole team is preparing for the final draft of the Chief Health Officer's report. An urgent request has come to provide data on patients admitted to hospitals due to type 2 diabetes mellitus in 2013-14. You are asked by your field supervisor to assist in preparing the response to this request, which involves conducting some data analysis. However, you have never worked on any hospital data before. Your tasks in this role are to:

- provide the total number of admissions (episodes) for type 2 diabetes in 2013-14 and the proportion of total hospital admissions this represents
- provide the total number of patients admitted to hospital with a primary diagnosis of type 2 diabetes in 2013-14 and the proportion of total patients this represents
- create a table to show the age and sex distribution of admissions for type 2 diabetes in 2013-14
- create a table to show age and sex distribution of patients admitted with a primary diagnosis of type 2 diabetes in 2013-14

Instruction 1

To get your head around the data you decide to start this work by navigating the dataset.

In the attachments, open up Stata file titled **"Raw 2DM Data".**

Question 1

a) Which year(s) are the data collected?

A: 2013-2014

b) How many variables are included in this dataset?

A: 26

c) How many episodes are in the dataset?

A: 90,952

d) How many patients are in the dataset?

Tip: Some patients might have multiple episodes but you should be able to identify the same person by patient ID. To ensure the same patient being counted only once, we can use the commands below.

```
gsort id +addttime
egen tag = tag(id)
order id tag
```

*sort id numbers by acceding order (+) of admission time into hospital, so when tag each patient, everyone's first admission would be tagged.

OR

```
gsort id -addttime
egen tag = tag(id)
order id tag
```

*sort id numbers by descending order (-) of admission time into hospital, so when tag each patient, everyone's last admission would be tagged.

Now browse the dataset and you will find each patient is only tagged once.

A: 43,136

Note: You can further use commands such as summarize, codebook, describe to explore the dataset if you like.

Instruction 2

Now you have started to get familiar with the dataset, it is time to do some thinking. This is a crucial step in data analysis: be clear of what you are looking for! First step is to think about what are your research questions?

Question 2

a) What are your research questions based on the tasks given above?

A:

1. How many **episodes** are contributed by type 2 diabetes and what is its proportion of the total?
2. How many **patients** are diagnosed with type 2 diabetes and what is its proportion of the total?
3. What is the sex and age distribution of admissions for type 2 diabetes in 2013-14?
4. What is the sex and age distribution of patients admitted with a primary diagnosis of type 2 diabetes in 2013-14?

b) What variables do you need for each of these questions? Consider we only use the primary diagnosis field to select conditions for this exercise.

A: Depend on your research questions, can include: pdx, id, tag, sex, agegp10,finyr

Instruction 3

To analyse people admitted to hospitals for particular conditions, we need to understand how the International Classification of Diseases (ICD) codes work. ICD is used to classify diseases and other health problems in administrative records, including death certificates and hospital records.[1] ICD-10-AM was developed by the National Centre for Classification in Health and has been in use since 1998. It was developed with assistance from clinicians and clinical coders to ensure that the classification is current and appropriate for Australian clinical practice. ICD-10-AM is a derived version of the World Health Organization (WHO) ICD-10. It uses an alphanumeric coding scheme for diseases and external causes of injury. It is structured by body system and aetiology, and comprises three, four and five character categories.[2] WHO ICD-10 can be downloaded from http://www.who.int/classifications/icd/icdonlineversions/en/

[1] World Health Organization (2015), Classifications – International Classification of Disease, accessed on 7 December 2015 via http://www.who.int/classifications/icd/en/

[2] Australian Consortium for Classification Development (2015), ICD-10-AM/ACHI/ACS, accessed on 7 December 2015 via https://www.accd.net.au/Icd10.aspx

Question 3

a) What ICD codes are used for type 2 diabetes? List five of them.

Tip: There are many four or five character ICD codes for type 2 diabetes, see the link below: http://www.icd10data.com/ICD10CM/Codes/E00-E89/E08-E13/E11-

A: E11.....

b) How many **episodes** are contributed by type 2 diabetes and what is its proportion of the total?

Tip: To group these codes, you might need to extract the first three characters using command substr.

A: 310

310/90952=0.34%

c) How many **patients** are diagnosed with type 2 diabetes and what is its proportion of the total?

A: 236

236/43,136=0.55%

Instruction 4

Age and sex distributions are among the most commonly asked questions for data analysis. To make things easier, patients' age has been grouped into 10-year categories.

Question 4

a) What is the sex and age distribution of admissions for type 2 diabetes in 2013-14?

Age group	**Male** **N=**	**Female** **N=**
Less than 10 yrs	1	0

10 to 19 yrs	0	0
20 to 29 yrs	1	0
30 to 39 yrs	2	8
40 to 49 yrs	17	9
50 to 59 yrs	38	23
60 to 69 yrs	50	26
70 to 79 yrs	57	26
80 to 89 yrs	21	24
90 or more yrs	2	5
Total	189	121

b) What is the sex and age distribution of patients admitted with a primary diagnosis of type 2 diabetes in 2013-14?

Age group	**Male** **N=**	**Female** **N=**
Less than 10 yrs	1	0
10 to 19 yrs	0	0
20 to 29 yrs	1	0
30 to 39 yrs	2	6
40 to 49 yrs	15	7
50 to 59 yrs	29	13
60 to 69 yrs	33	18
70 to 79 yrs	46	21
80 to 89 yrs	17	20
90 or more yrs	2	5
Total	146	90

Data dictionary

Variable	Measurement Level	Label	Value	Labels
hospital	Nominal	Hospital Identifier	1	Hospital A
			2	Hospital B
ID	Scale	Patient ID from Hospital		
sex	Nominal	Sex	1	Male
			2	Female
			3	Indeterminate
			9	Inadequately described or not stated
agegp10	Nominal	ACT 10 year age groups	0	Infant, neonate or newborn
			1	Less than 10 yrs
			2	10 to 19 yrs
			3	20 to 29 yrs
			4	30 to 39 yrs
			5	40 to 49 yrs
			6	50 to 59 yrs
			7	60 to 69 yrs
			8	70 to 79 yrs

			9	80 to 89 yrs
			10	90 or more yrs
indigen	Nominal	Indigenous status	1	Aboriginal but not Torres Strait Islander origin
			2	Torres Strait Islander but not Aboriginal origin
			3	Both Aboriginal and Torres Strait Islander origin
			4	Neither Aboriginal nor Torres Strait Islander origin
			9	Not stated/inadequately described
mcat	Nominal	Marital status	1	Never married
			2	Widowed
			3	Divorced
			4	Separated
			5	Married (including de facto)
			6	Not stated or inadequately described
postcode	Nominal	Generic Postcode		
urgadm	Nominal	Urgency of Admission	1	Urgency status assigned - emergency
			2	Urgency status assigned - elective
			3	Urgency status not assigned
			9	Not known / Not reported

caretype	Scale	Care type (from 1/7/2000)		
			10	Acute care
			20	Rehabilitation care
			21	Rehab in designated unit
			22	Rehab as designated program
			23	Rehab principal clinical intent
			30	Palliative care not further described
			31	Palliative in designated unit
			32	Palliative in designated program
			33	Palliative principal intent
			40	Geriatric evaluation and management
			50	Psychogeriatric care
			60	Maintenance care
			70	Newborn - further status not able to be determined
			71	Newborn Care - qualified days only
			72	Newborn Care - qualified and unqualified days
			73	Newborn Care - Unqualified days only
			80	Other admitted patient care
			90	Organ procurement - posthumous care

			100	Hospital Boarder
insure	Nominal	Patient insurance status	1	Hospital insurance
			2	No hospital insurance
			9	Not stated / not known
addttime	Scale	Date and Time of admission - Date Format		
spdttime	Scale	Date and Time of separation-Date Format		
sepmode	Nominal	Mode of separation	1	Discharge or transfer to acute hosp
			2	Discharge or transfer to nursing home
			3	Discharge or transfer to psych hosp
			4	Discharge or transfer to health care accom
			5	Statistical discharge-type change
			6	Left against medical advice
			7	Statistical discharge from leave
			8	Died
			9	Discharged home or other or welfare inst
pdx	Nominal	Primary Diagnosis Code		
dx2	Nominal	Additional diagnosis - 2		

dx3	Nominal	Additional diagnosis -3		
dx4	Nominal	Additional diagnosis - 4		
dx5	Nominal	Additional diagnosis - 5		
dx6	Nominal	Additional diagnosis - 6		
dx7	Nominal	Additional diagnosis - 7		
dx8	Nominal	Additional diagnosis - 8		
dx9	Nominal	Additional diagnosis - 9		
finyr	Scale	Financial year		
cob_aus	Nominal	Country of Birth - Australia & NZ and Minor Country Groups (ASCCSS)	1	Australia
			2	New Zealand
			3	Other Oceania
			4	Europe and Former USSR
			5	Middle East & North Africa
			6	Southeast Asia
			7	Northeast Asia
			8	Southern Asia

			9	Northern America
			10	Sth/Cen America/Caribbean
			11	Africa (Exc Nth Africa)
			99	Not Stated or inadequately described
smokeapc	Scale	Tobacco use, using APC codes	1	past tobacco use (in last 5 years, but not last month)
			2	current tobacco use
			3	harmful tobacco use
			4	tobacco dependence syndrome
			5	tobacco withdrawal
			6	counselling for tobacco
			7	toxic effect of tobacco and nicotine
			8	foetus and newborn affected by maternal use of tobacco
			9	other disorders due to tobacco use
			99	No tobacco use coded

Appendix 2: Presentation for the teaching session for first year MAE students

Australian National University

Case-control studies versus Cohort studies

What's the difference?!?!

Australian National University

Learning objectives

Give the students the ability to:

- Characterise and identify case control vs cohort study
- understand pros and cons for cohort and case control study
- Determine appropriate study designs to investigate outbreaks

Australian National University

Outline

- Introduction
- Quiz 1
- Case study
- Quiz 2

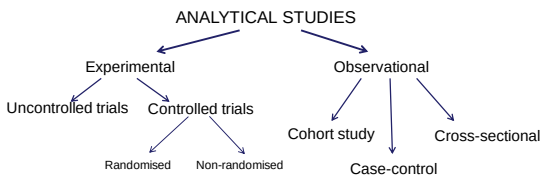
Australian National University

Cross-sectional, cohort or case control

- Which study
  - Always selects cases based on the exposure?
  - Always selects subjects based on the outcome?
  - Cannot assess cause and effect?
  - Is good for looking at rare diseases?
  - Can be used to look at numerous exposures?
  - Is good for rare exposures?
  - Is generally quick and cheap?
  - Can measure multiple different outcomes?

Australian National University

Types of studies



Australian National University

Cross-sectional studies

- Cross-sectional study (prevalence study)
  - Looks at disease and exposure at one point in time, therefore cannot assess cause and effect as the temporal relationship cannot be determined.

Cohort studies

- Cohort studies - starts with the exposure
  - Can be retrospective or prospective

Cohort studies

- Cohort studies - starts with the exposure
  - Can be retrospective or prospective
- Prospective cohort studies
  - You can set up the study and follow the cohort from then on

Cohort studies

- Cohort studies – starts with the exposure
  - Can be retrospective or prospective
- Prospective cohort studies
  - You can set up the study and follow the cohort from then on
- Retrospective cohort studies
  - You can select a cohort and see what happened to get them to this point

Case-control studies

- Case-control studies – starts with the outcome
  - Are always retrospective

Case-control studies

- Case-control studies – starts with the outcome
  - Are always retrospective

Why?

Case-control studies

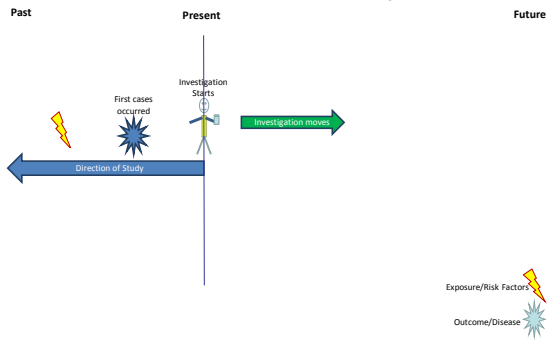
- Case-control studies – starts with the outcome
  - Are always retrospective

Why?

- Because you have chosen the study subjects according to the outcome/disease status i.e. CASE - if they have the disease/condition/outcome, or CONTROL – do not have the disease/condition/outcome

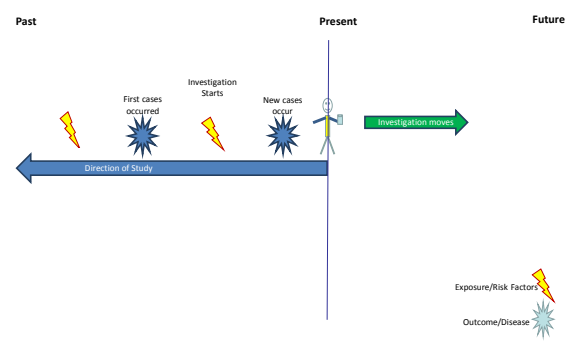
Australian National University

Jo's Salmonella Study



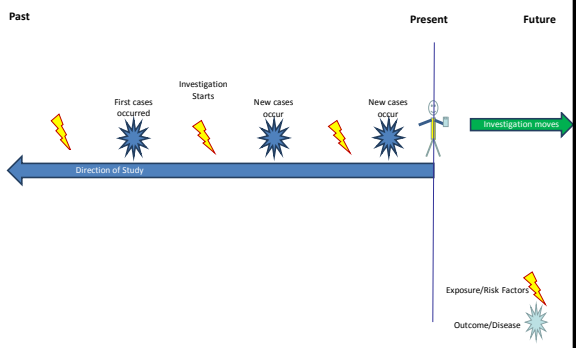
Australian National University

Jo's Salmonella Study



Australian National University

Jo's Salmonella Study



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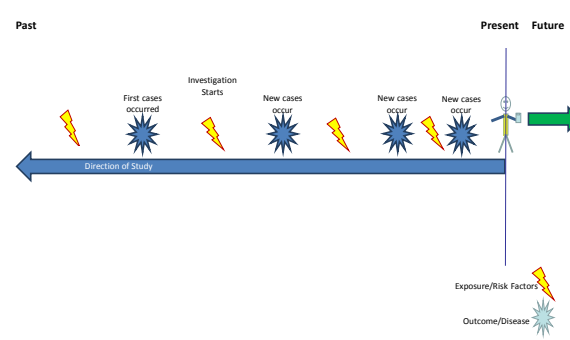
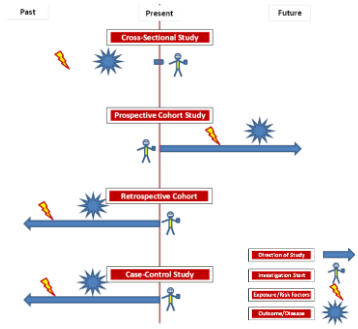


Australian National University

Case-control versus cohort studies



Australian National University

Cohort VS case control

	Cohort	Case-control
Study characteristics	Start with exposure risk factor → follow up to see who gets disease	Start with disease → look back to see what risk factors subjects were exposed to

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Measure	Relative Risk (can use odds ratio but RR better)	Odds Ratio

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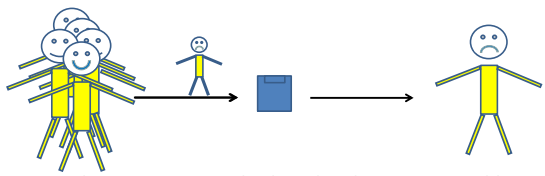
Whoa – what?!?!

Paul's Salmonella Study



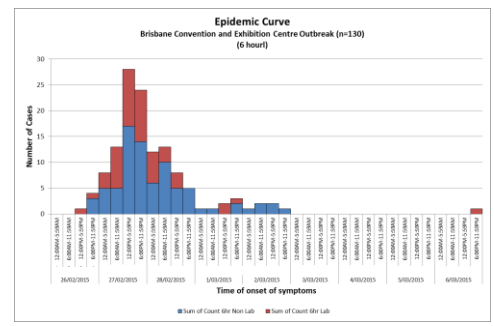
Attendees: 1418

Completed questionnaire: 723

Sick: 140

21

Paul's Salmonella Study



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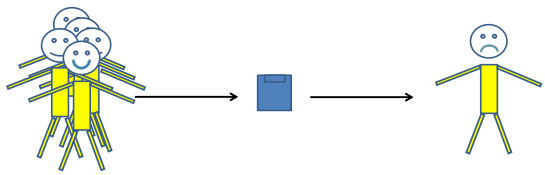
Paul's Salmonella Study



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What study would you use?
What measurement of association would you use?

23

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Strengths	• Many different outcomes can be measured • Good for rare exposures • Can measure incidence and prevalence	• Many different exposures can be measured • Good for rare diseases • Good for disease with long latency periods • Relatively quick and cheap

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Strengths	• Many different outcomes can be measured • Good for rare exposures • Can measure incidence and prevalence	• Many different exposures can be measured • Good for rare diseases • Good for disease with long latency periods • Relatively quick and cheap
Weaknesses	• Not good for rare diseases • Can take a long time to run → expensive • Bias issues - loss to follow up - misclassification/selection bias - healthy worker effect	• Not good for rare exposures • Not as powerful as cohort in determining causal relationships • Bias issues - recall - selection - observer - sampling

Quiz 1

Cross-sectional, cohort or case control

- Which study
  - Always selects cases based on the exposure?
  - Always selects subjects based on the outcome?
  - Cannot assess cause and effect?
  - Is good for looking at rare diseases?
  - Can be used to look at numerous exposures?
  - Is good for rare exposures?
  - Is generally quick and cheap?
  - Can measure multiple different outcomes?

Cohort or case-control

1. In a study looking at risk factors for Tularemia infection in Sweden, researchers identified and included as study subjects 270 persons notified with Tularemia infection over a four month period and a further 438 persons without a notification for Tularemia over the same time period. This latter group of study subjects were randomly selected from the Swedish National Population Register. Is this a cohort or case-control design to assess risk factors for Tularemia?

Eliasson et al. 2002

Cohort or case-control

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Eliasson et al. 2002

Cohort or case-control

2. An outbreak of salmonellosis was identified at a high school graduation party. The investigating team interviewed 23 of the 24 graduation party attendees and collected information on potential exposures. All cases were later confirmed by laboratory analysis of stool samples, and data analysed to determine associations between exposure and salmonellosis. Is this a cohort or case-control design?

Cohort or case-control

2. An outbreak of salmonellosis was identified at a high school graduation party. The investigating team interviewed 23 of the 24 graduation party attendees and collected information on potential exposures. All cases were later confirmed by laboratory analysis of stool samples, and data analysed to determine associations between exposure and salmonellosis. Is this a cohort or case-control design?

What would you do?

3. An increase in cryptosporidium notifications was detected in the state of Victoria from an average of 1 case/month to 23 cases/month. An MAE student was interested to determine possible risk factors associated with infection, to initiate a public health response. What study should she do – case-control or cohort?

What would you do?

3. An increase in cryptosporidium notifications was detected in the state of Victoria from an average of 1 case/month to 23 cases/month. An MAE student was interested to determine possible risk factors associated with infection, to initiate a public health response. What study should she do – case-control or cohort?

Population?

Exposure?

Cecilia's *Clostridium perfringens* Study

Case Study – Scenario 1

Sunday 14 June 2015

Case Study – Scenario 1

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Case Study – Scenario 1

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Case Study – Scenario 3

Function

- held on Friday 12 June from 16:30-21:00
- estimated 2000-3000 attendants
- food was provided by the on-site café
- staff ate together when function concluded

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Case Study – Scenario 2

Monday 15 June 2015- interviewing cases

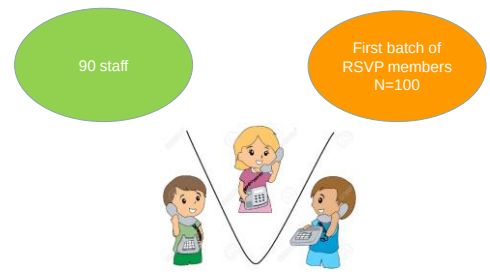
- Symptoms
  - diarrhoea, abdominal cramps, fever, vomiting;
- Onset time
  - approx 12-15 hrs post exposure
- Duration
  - 1-24 hours

40

Case Study - Epi Investigation

41

Case Study - Epi Investigation



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Case Study – Question

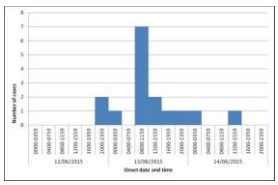
- What study would you choose to investigate this outbreak?
- Why?

Case Study - What we did

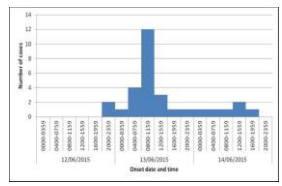
- Cohort study
  - Staff ate function food at the venue on 12 June (n=45)
- Case control study
  - All cases found in both public and staff members (n=58)

Case Study - Epi Curve

Staff cohort



Staff and Public Case Control



Quiz 2

Cohort or Case-control

On Tuesday July 14th 2015, the DHHS was alerted by Hospital X and the local council of gastrointestinal illness in 11 members of a group of 25 who attended High Tea at Hotel L on Saturday July 11th. Five cases were hospitalised and one tested positive for *Salmonella*.

Preliminary investigation revealed that whilst the majority of cases (450) attended Hotel L on the weekend of July 11th, cases also attended High Tea at Hotel L throughout the previous week from July 6th onward. A booking list subsequently obtained from Hotel L for July 6th - 12th inclusive revealed that 1000 guests had attended High Tea during this period, which was exceptionally busy on account of it being school holidays. The booking list obtained contained the name and contact telephone number of the individual who made the reservation, as well as the size of each group.

You decide to perform an analytic study to determine the risk factor associated with illness and implement a public health response.

What study would you do – a cohort, or a case-control?

Cohort or Case-control

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Cohort or case-control

4. In a study to assess the association between Azithromycin levels in high vaginal specimens and treatment failure for Chlamydia trachomatis, researchers recruited all women who tested positive for genital chlamydia at two large sexual health centres in Australia. Participants were followed up for 56 days post treatment for evidence of treatment failure and levels of azithromycin were measured. Is this a cohort or case-control study design?

Hocking et al. 2013

Cohort or case-control

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Defined cohort

Outcome

Exposure/treatment

Hocking et al. 2013